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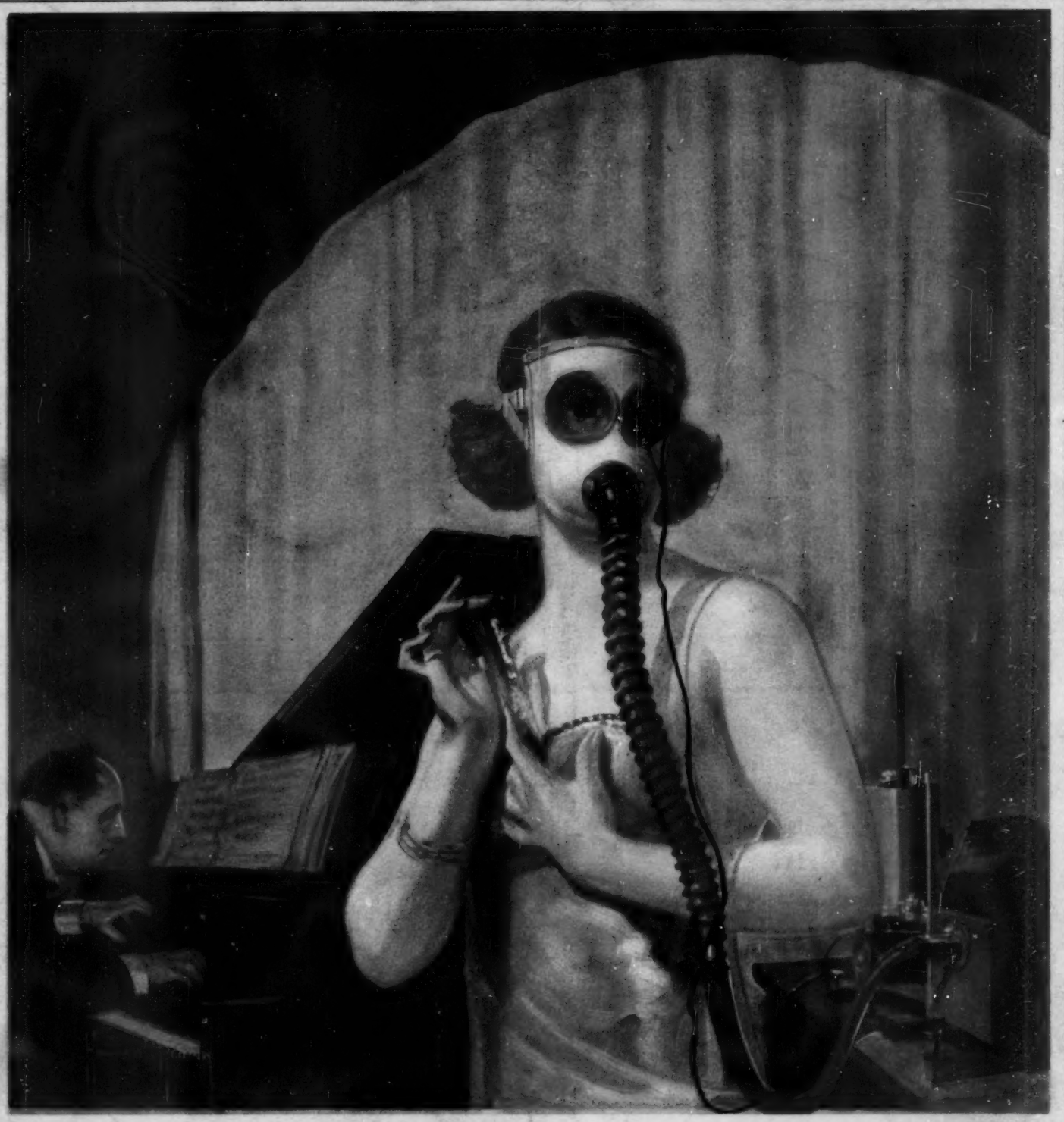

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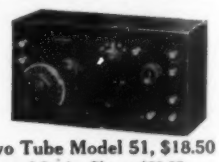

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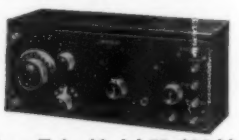

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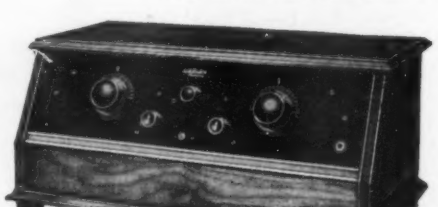

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Automobiles

IN the January issue of each year the SCIENTIFIC AMERICAN has been accustomed to print a summary of all types of automobiles, both pleasure cars and trucks, which are to be offered by American manufacturers. This list for 1925 will appear in the next issue. It will include the essential facts of design, power, cost and the like. If you contemplate buying a car during 1925 this list in the January issue will be invaluable to you.

In the same issue the well-known automotive engineer, Mr. H. W. Slauson, M. E., will write an article summarizing the chief developments of the automotive industries in 1924 and predicting the probable trends for 1925.

Gold

IN the course of its efforts to present scientific truth to the American public the SCIENTIFIC AMERICAN is frequently compelled to ascertain for itself just what the truth is. An instance has arisen in the report of the German Professor Miethe, who believes that he has made gold out of quicksilver.

If he really has done this it is not likely that he will make himself rich. It is much more likely that he will make everybody poor.

The facts about this remarkable experiment need to be found out and explained. As announced on page 389 of this issue the SCIENTIFIC AMERICAN proposes to find out about them. We are going to try making some gold ourselves and we are going to find out how much it costs.

Lost

MONTHS ago someone sold us an article on vitamines. The manuscript got separated from the correspondence. The manuscript does not carry the author's name. We have the manuscript but we do not know who ought to have the check. If you are the missing author, write and tell us so.

Radio

DURING the past two months some hundreds of readers and subscribers have asked us what radio set they ought to buy. We are going to answer their questions in the only way that is both fair and satisfactory. We will publish the essential facts about every type of ready-for-use radio set on the American market which passes the inspection of our radio engineers.

There are almost as many kinds of radio sets as there are automobiles. Some work on loop antennas, others only on an outside wire. Some need storage batteries, others use dry batteries, still others can be arranged for either kind. Some sets use one tube, others use eight or ten. Prices range from less than fifteen dollars to a thousand dollars or more. The particular set that you ought to buy depends on what you want, where you are and how much you want to spend. The only way to tell you is to give you the essential facts and let you choose for yourself.

We will print next month a list of all American sets the quality of which we approve, with full information about each. The information is now being collected and tabulated. Sets unknown to us are being tested. This information, kept continually up to date, will run regularly in the SCIENTIFIC AMERICAN during the winter months. It will be a buyers' guide for the radio fan who wants to buy a set rather than to build one.

In the present issue radio fans will be interested in the article of Mr. Stanley and Dr. Sheldon on page 381. Radio methods have been used to help these remarkable new tests for singers. On page 391 is Mr. Delano's description of the famous Holweck tube. With it we print the first laboratory photograph of Professor Holweck which he has allowed to be made. In Mr. Lescarboura's radio page for this month (page 390) are the latest wrinkles in loudspeakers.

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Psychic

THE Psychic Committee is now at work holding additional tests of the medium, "Margery." As yet the Committee has made no further report. We are informed that friends of this medium will supply to us for publication in the January issue a statement controverting certain allegations made recently in the daily papers about this case. If this statement is supplied, we shall print it.

Meanwhile we print in this issue, on page 384, an account of some remarkable and mysterious personal experiences by the Chairman of our Psychic Committee, Dr. Prince.

Shadows

IN the November issue we announced our radio investigation of the solar eclipse, next January. Another announcement will be found on page 388 of the present issue. Many enrolments of listeners have already come in. There is room for more, especially in the Middle Western States and in New England. Turn to page 388 and send in your enrolment today.

Cooperating in this investigation is a committee of the American Astronomical Society, headed by Professor E. W. Brown, the eminent astronomer of Yale University. Professor Brown informs us that his committee desires also that certain important observations be made by the general public.

One of the things to be observed is the exact time of the eclipse. Another is the exact border of the path of total shadow. Still another is the phenomenon of "shadow bands," the strips of light and dark that chase each other along in advance of the eclipse. Good observers, even if they are not trained astronomers, can do real work for science by observing these things and reporting what they see.

Exact instructions will be issued by Professor Brown's committee. We will publish them in full in the January issue of the SCIENTIFIC AMERICAN, out December 20. If you are not a subscriber you had better tell your newsdealer now to reserve a copy for you, or send us thirty-five cents and tell us to mail you one.

Disappointment

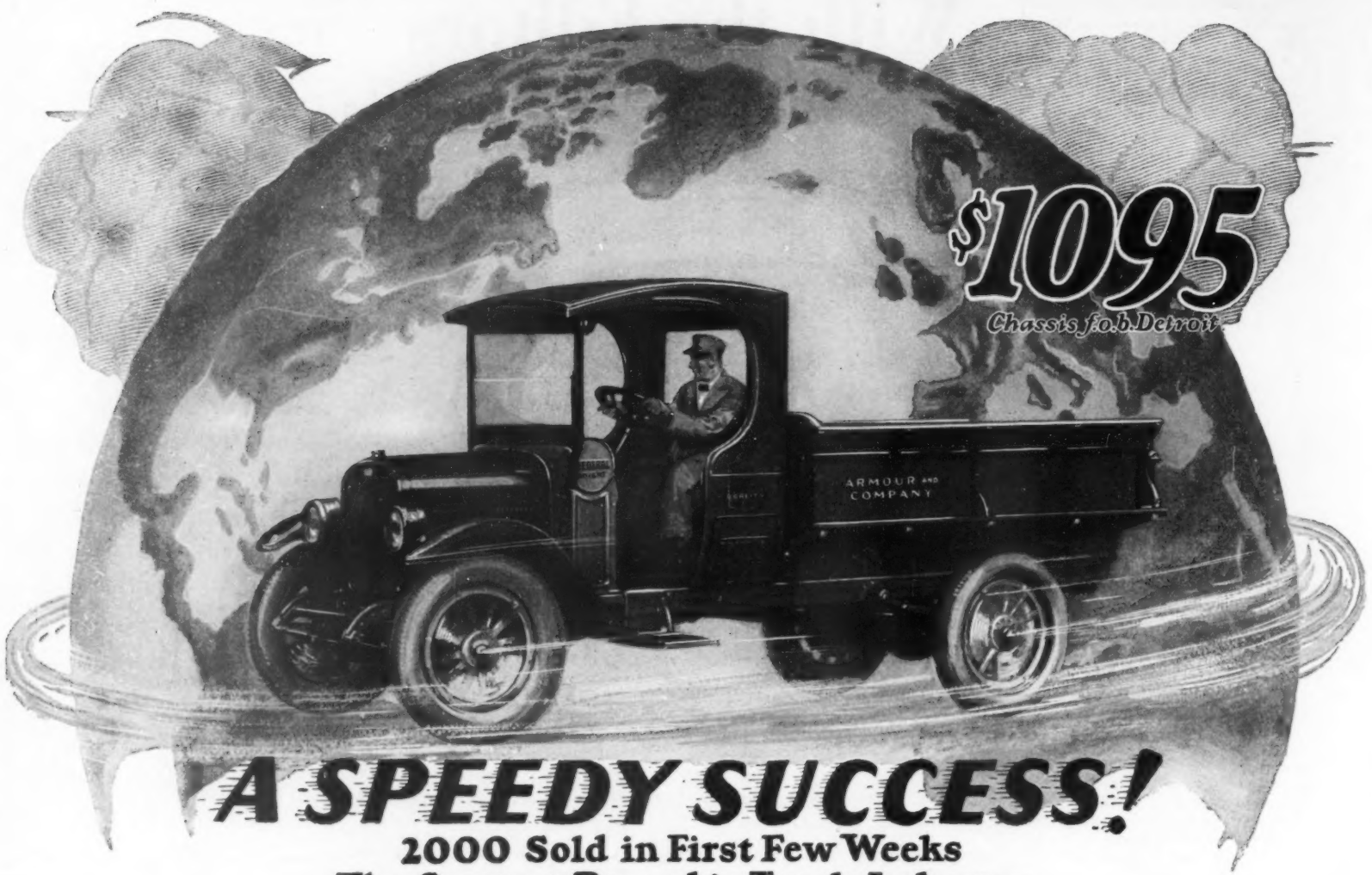
THE supposed cancer cure in Paris, which we mentioned on this page last month, has not stood up under the searching investigation of our Paris representatives. We do not mean that it is fraudulent. On the contrary, the work done is most interesting and has high scientific value. But it is not—at least, not yet—a "cure." Perhaps it may be some day. In the meantime we will continue to watch the progress of the experimentation. When there are unquestionable facts to report we will report them.

Sand

OUT of the sands of the northern coast of Africa, the same sands that swallowed up the ruins of the once great city of Carthage, they are digging the remains of another city, the Roman town of Leptis Magna, birthplace and home town of the Emperor Severus. On page 387 of this issue we print photographs of some of the remarkable ruins that have been uncovered. The descriptive text has been corrected especially for the SCIENTIFIC AMERICAN by Dr. Bruno Rosselli, who has recently visited the excavations.

Agreement

WE are glad to announce that the controversy with the Scientific American Compiling Department, Inc., associated with the Encyclopedia Americana Corporation, over the use by them of the name "Scientific American" has been adjusted satisfactorily by the agreement of these corporations not to use this name in any manner whatsoever. There is no connection between these corporations and the publishers of the SCIENTIFIC AMERICAN.



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SCIENTIFIC AMERICAN

THE MONTHLY JOURNAL OF PRACTICAL INFORMATION

NEW YORK, DECEMBER, 1924

Scientific Tests for Good and Bad Singers

A Description of New Research on Methods of Determining the Characteristics and Possible Development of Singers Voices

By Douglas Stanley, M.S. and H. H. Sheldon, Ph.D.
New York University

WHETHER the voice of a prospective singer has a chance of developing sufficiently to justify the expense and labor of training it is a problem that must be faced by the conscientious singing teacher every time that a new pupil presents himself. The answer is, necessarily, a matter of guesswork. Even a musician's judgment of the quality of a well-trained voice depends on nothing more solid than opinion.

This opinion may be based on wide experience and it may be right. Similarly, the experienced teacher may be able to guess, with fair accuracy, at the possible future of an untrained voice that he hears. In the ability to do this resides a large part of his special skill.

But it would be better, every teacher will admit, if it were possible to do these things in some definite and measurable way; if we possessed some instrument capable of determining the characteristics of a voice with as great precision, for example, as the instruments of the oculist are able to determine the characteristics of your eye. Even more urgently needed, from the teacher's standpoint at least, is some way of determining with scientific accuracy just what it is that is the matter with a given voice and just what things must be done, physically or physiologically, to remedy the imperfections that exist.

Singing is essentially a physical act, quite as much so as seeing. Yet the science of physics has made important contributions to the study and improvement of the human eye and practically none to the study of the singing voice. It has seemed to us that there is an important opportunity here for useful physical investigations and the experiments now reported are intended as a first step in this direction.

The fundamental act performed in singing is the expulsion of breath from the lungs. This breath is forced through a narrow opening between the two vocal cords in the throat, producing a humming or sizzling noise. This noise is modified by resonance in the air-filled passages in the head, throat and chest and comes out as the sung tone.

In attacking this matter from the viewpoint of the science of physics it would be possible to study by physical methods many different aspects of the operation of tone production. Indeed it undoubtedly will be necessary to study all these aspects before science will have exhausted the subject. But to make a beginning and to do so in a sufficiently simple way it seemed best to study only one feature of the voice production, namely, the expulsion of the breath. This is certainly the most fundamental thing about a voice, for if no breath were expelled there could be no voice. Furthermore, it has been universally held and taught by singing experts that the "breathing" is an all-important factor in the proper production of a tone and the proper training of a voice.

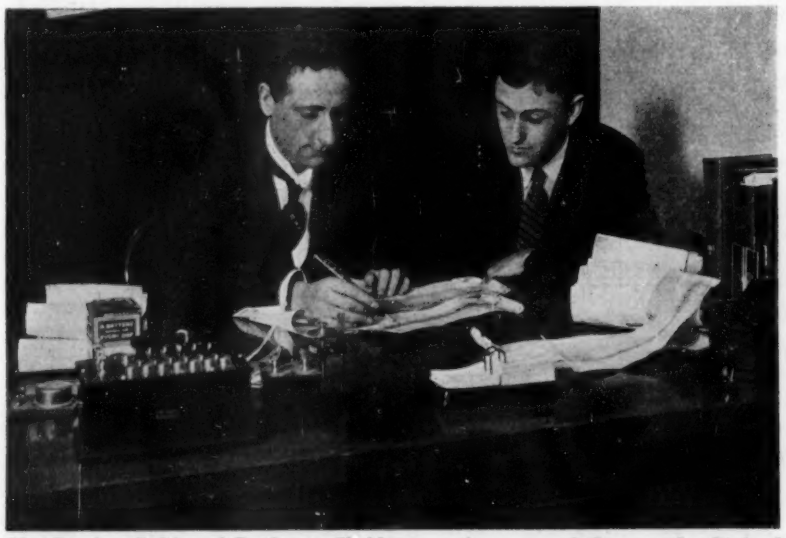
The present study included, therefore, a record of the amount of breath expelled per second in the singing of a tone, as compared with the pitch and the loudness of the tone sung. These records were made, also, with a number of singers; some well trained, others almost without training. It is possible, therefore, to deduce a number of conclusions about the action of the breath in the production of sung tones of different character and about how this use of the breath may serve to indicate faults of singing technique and, in some cases, the ways to correct these faults.

The apparatus used consists of a device to measure the breath expelled and another device to measure simultaneously, the character and loudness of the tone produced.

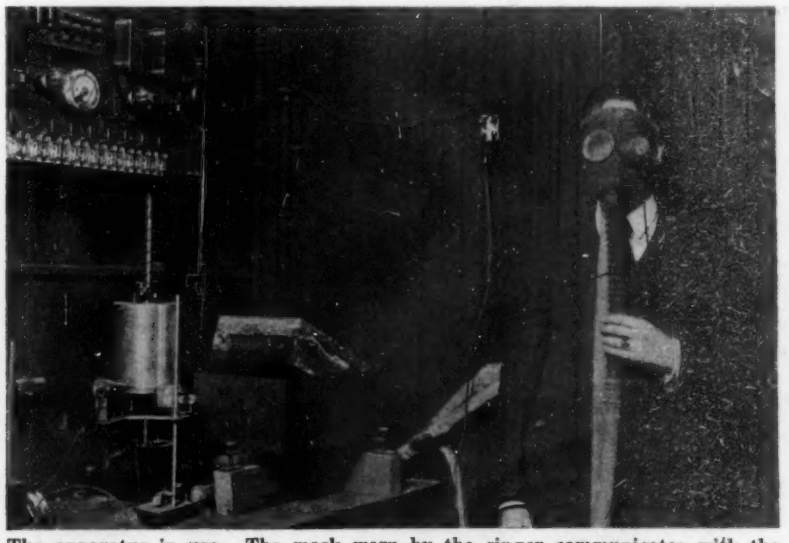
The breath-measuring device—called a spirometer—is connected to a large rubber tube which leads, in turn, to a rubber mask strapped tightly over the singer's face. The other end of this tube discharges underneath a light, air-tight box inverted in a tank of water. A two-way flutter valve in the tube allows air to be breathed in from the room but compels all outgoing air to pass through the tube and into the inverted box. The gradual rise of this box as it fills with air and floats higher and higher in the water gives a measure of the amount of breath expelled.

In some of our earlier experiments the rise of this box was recorded by a lever system by which a sharp point was pressed on the surface of smoked paper on a revolving drum, where it scratched a line as the box of the spirometer rose. This method was abandoned because of the fear that errors were being introduced by the friction of the sharp point on the paper. As a substitute an optical system was arranged. A small spot of light was focussed on a mirror fastened to the box. As the box rises this light-spot traces a line on a moving sheet of especially sensitized photographic paper supplied by the Eastman Kodak Company. From this line it is possible to read off the exact amount of breath expelled each second in the singing of a specified tone.

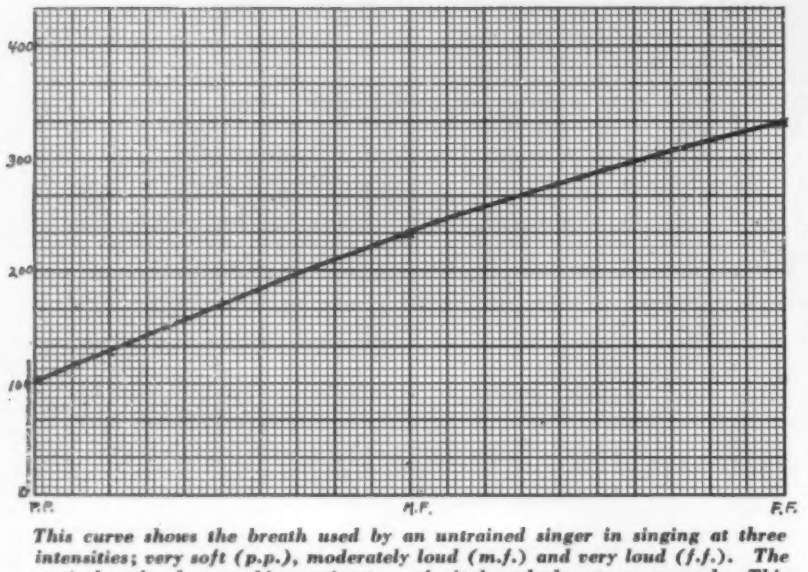
At the same time the sound produced is picked up by a special telephone transmitter inserted in one of the eyeholes of the mask worn by the singer. From this telephone the electrical impulses corresponding to the sound produced are passed through a special amplifier, similar to the amplifiers used in radio, and thence to an instrument called an oscillograph, which is a device



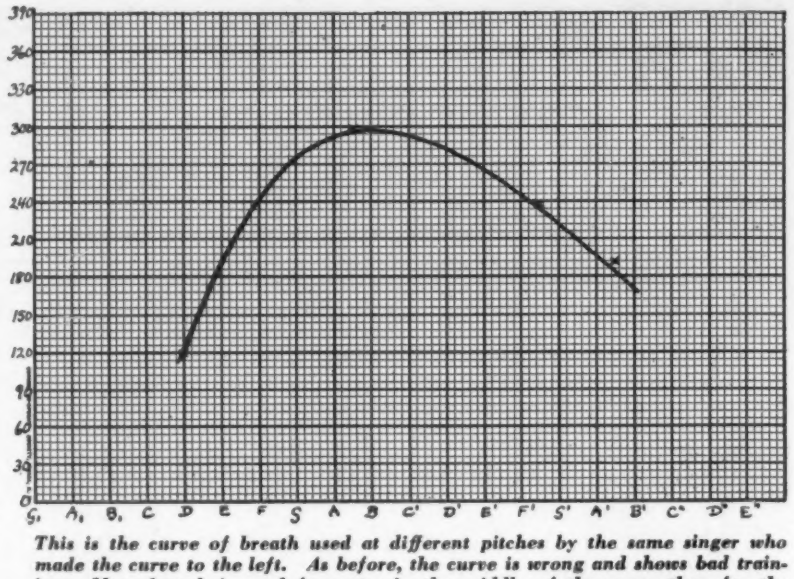
Mr. Stanley (left) and Professor Sheldon examine some of the records obtained in these investigations. Samples of these records are reproduced on page 383



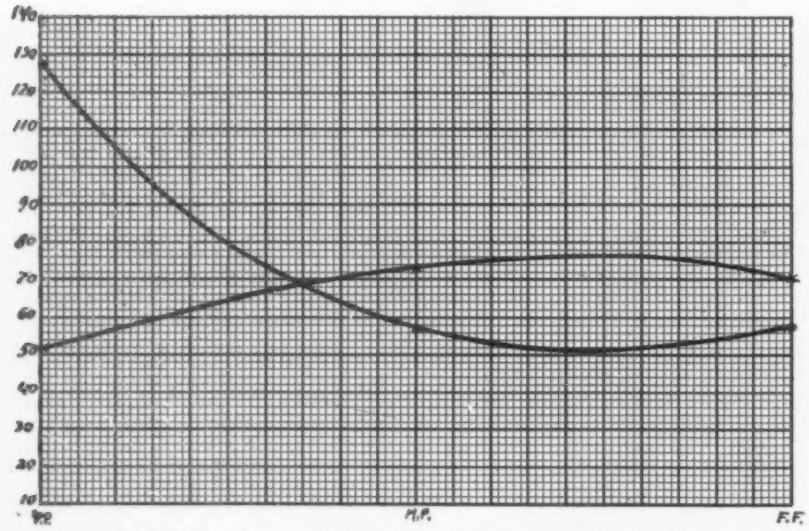
The apparatus in use. The mask worn by the singer communicates with the spirometer box shown on the table. Beside this is the recording device



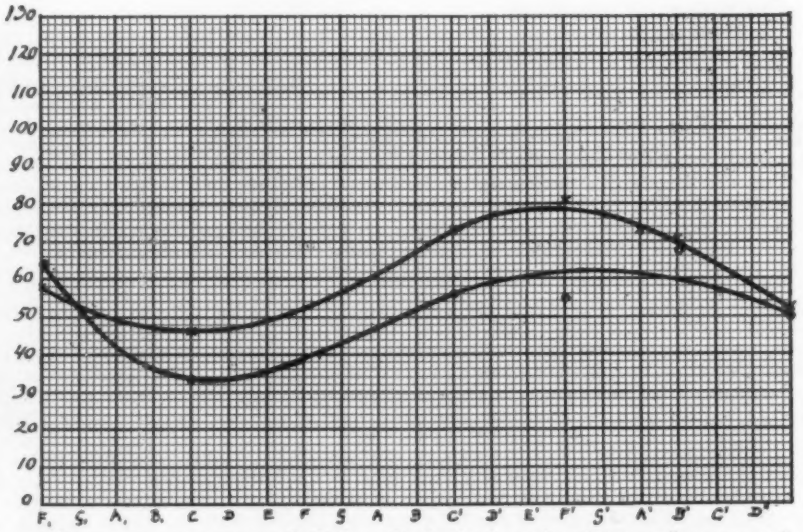
This curve shows the breath used by an untrained singer in singing at three intensities; very soft (p.p.), moderately loud (m.f.) and very loud (f.f.). The vertical scale shows cubic centimeters of air breathed out per second. This increases with the loudness, which is wrong and is characteristic of bad training or no training



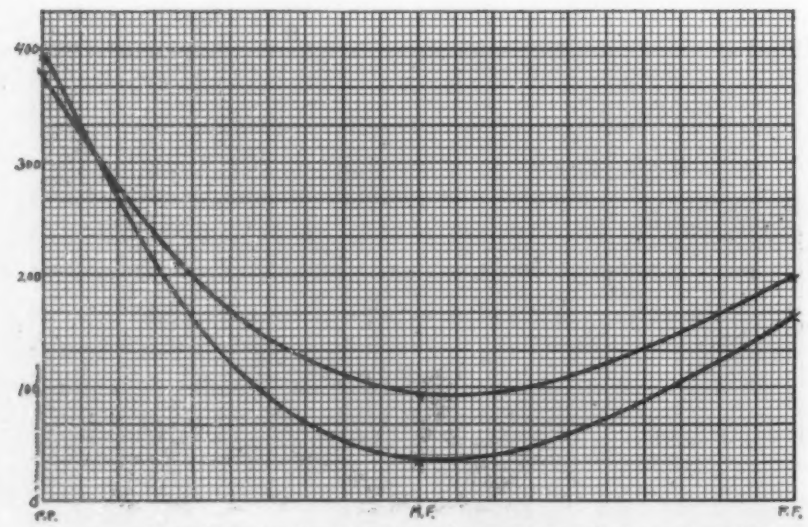
This is the curve of breath used at different pitches by the same singer who made the curve to the left. As before, the curve is wrong and shows bad training. More breath is used for notes in the middle of the range than for the high or the low notes. A well-trained voice shows exactly the reverse of this, as is indicated by the bottom curve below



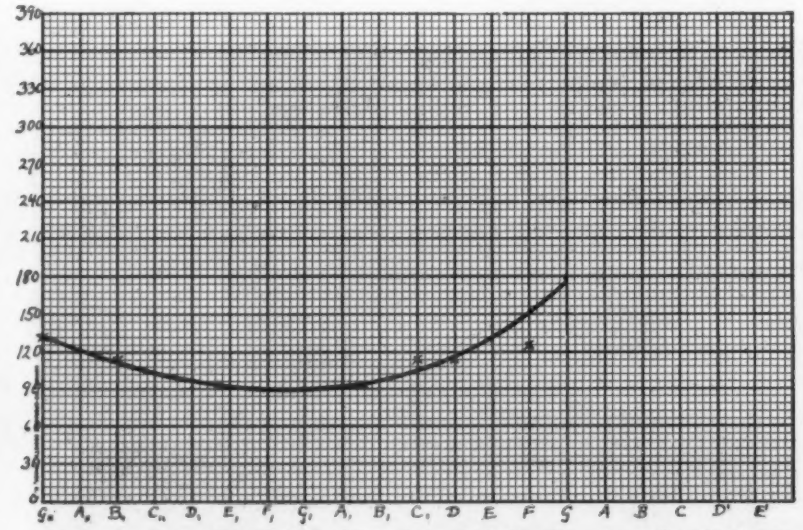
The one of these two curves that begins at 50 on the left-hand scale was made before training was begun. It indicates an imperfect voice. The other curve, made after some months' training, shows improvement. It begins to resemble in form the curve of a well-trained voice, a curve bowed downward in the center, like those below



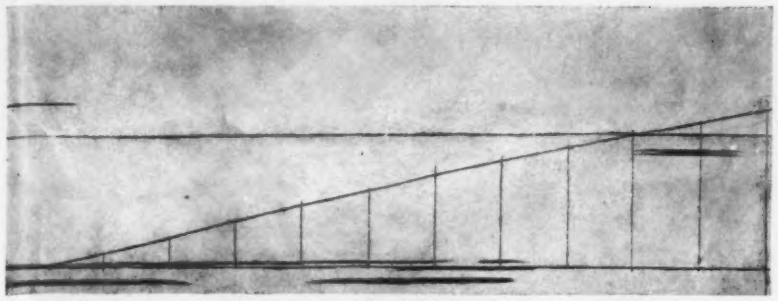
The upper curve was made before the beginning of training and corresponds to the first-mentioned curve of the drawing to the left. The lower curve shows the effect of training in decreasing the amount of breath needed for each note. But the twisted form of this curve shows that the voice is still somewhat imperfect although the lowering of the second curve shows improvement



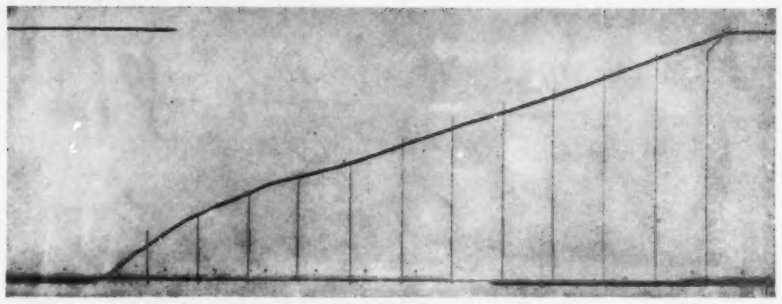
This curve shows how the breath ought to be used in producing soft, moderate and loud tones. The moderate intensity requires least breath. The soft tone uses most of all. This is the typical breath-output curve obtained with a well-trained voice or with one that has a proper natural coordination of the muscles



This curve shows the relation of breath to pitch for the same well-trained voice shown at the left. The curve is nearly flat, indicating that the breath used for a given note does not depend very much upon the pitch except that a little more breath is needed for both the highest and the lowest notes



One of the breath-output records made by the spirometer, showing a uniform expulsion of the breath



Another breath-output record that is much less uniform. The vertical lines mark seconds of time

that records on moving photographic film the exact wave form and intensity of the sound waves produced inside the mask. The telephone and amplifier, both adjusted to be as free as possible from any tendency to modify or distort the tone, were supplied by the Western Electric Company. The oscillograph was supplied by the General Electric Company.

If a singer dons the mask and sings into this apparatus there are obtained two records. One is the spirometer curve that shows the breath emitted. The other is the oscillograph curve that shows the pitch, the loudness and something of the general character of the tone. If the singer sings several notes of different pitches or the same note at several different degrees of loudness, it is possible to determine the amount of breath expelled per second for each of these notes and thus to construct curves showing the relation of breath emitted to pitch and to loudness, some of which curves are shown herewith on page 382.

In the curves on that page "ff" is the musician's term for "fortissimo," meaning very loud; "mf" is "mezzo forte," meaning moderately loud; "pp" is "pianissimo," meaning very soft. On the right-hand curves, which give the relation of breath-output to pitch, the different pitches are designated in the usual musical notation, the higher-pitched notes being at the right of the curves. The vertical scale, in all cases, indicates the amount of breath emitted, measured in cubic centimeters per second.

It is still too soon to be able to apply such curves to the determination of all the characteristics of a singer's voice but some of the characteristics can be determined without difficulty. For example, the upper left-hand curve of page 382 shows the relative amounts of breath used by this particular singer in producing the same tone at three different intensities; very loud, moderately loud and soft. It is seen that the loud tone requires the most breath; the moderately loud tone the next; and the soft tone the least breath of all.

This seems quite as it should be but as a matter of fact it is wrong. This singer was not well trained. The voice was not perfect, even from the musician's viewpoint. Tests made during this investigation have shown, quite definitely, that the breath output of a well-trained voice does not have this shape of curve at all but has instead the shape of the curve in the lower left-hand corner of page 382. With well-trained singers the production of a soft tone actually requires *more* breath than the production of moderately loud tone or even, in most cases, of a very loud one.

This surprising and apparently paradoxical result finds, however, a ready physical explanation when we examine a little more closely the way in which sung tones are actually produced by the mechanism of the human voice.

The voice originates, as we have seen, in the vocal cords. These are not really "cords" at all but are two ridges of tissue that extend part way across the small box-like enlargement of the windpipe that we call the "Adam's apple." By more or less complicated sets of muscles these two ridges can be drawn close together so that only a very narrow slit is left between them or can be allowed to relax and drop back so that the throat is left quite clear, as it is in normal breathing when no speech sound is being produced.

The noise produced by these vocal cords is a hum or hiss that contains many different musical notes all mixed together. The thing that causes a definite and pure note to be sounded is the resonance in the air passages of the throat and in the back of the mouth and nose. That is why it is necessary for a singer to learn how to control very precisely, not only the muscles that move the vocal cords but also the many muscles that determine the exact shapes and sizes of all the throat passages, as well as the variable-sized passages of the back part of the mouth and the back part of the nose.

The vocal cords also operate to control the *loudness* of the tone. If the original hum of the vocal cords is loud (resonance conditions being correct), the sung

Mr. Stanley demonstrates resonance. When one of the forks is struck the other fork, tuned to the same note, is set into vibration

tone will be loud; if the hum is soft, the sung tone will be soft. Therefore, when we study the relation of the amount of breath used to the loudness of the tone we are really studying, in the main, the behavior of the vocal cords.

Suppose that a singer begins to sing a tone softly and gradually swells it in loudness, keeping the pitch and vowel unchanged. Since the pitch and vowel sound do not change we know that the shapes and sizes of the resonating cavities remain unaltered. What does change is that as the tone grows louder the vocal cords are brought closer and closer together. At the natural voice intensity, corresponding to a moderately loud or "mf" note, the cords will be practically touching. The air will pass through them in a series of puffs, thus producing the hum of the cords. This will be, physically, a very efficient method. We find that it actually is so, for these investigations show that the moderately loud notes are produced with less air than are notes of any other intensity. This is typified by the lower, left-hand curve of page 382.

On the other hand, if the note being sung is a softer one the vocal cords will be farther apart. The air will pass over them with a bowing effect, like the effect of wind blowing through a fairly large crack. This will not be an efficient method of sound production. More air will be required to make any noise at all. This is the explanation of the apparent paradox established by these experiments—the paradox that it takes much more breath to sing a soft tone than to sing a loud one.

But why is this not true with all singers? Why do untrained or badly trained voices fail to obey this rule? And how can this result be made use of in judging of the technique of a singer or of a student?

To answer these questions we must refer for a moment to what are called the "registers" of the voice. In the untrained voice two definite registers will usually be observed. In a man we have the so-called "falsetto" and the ordinary or "chest" voice. In a woman we have the "upper" voice and the "chest" voice. Ordinarily there is a definite break between these two registers, so that they sound like two different voices.

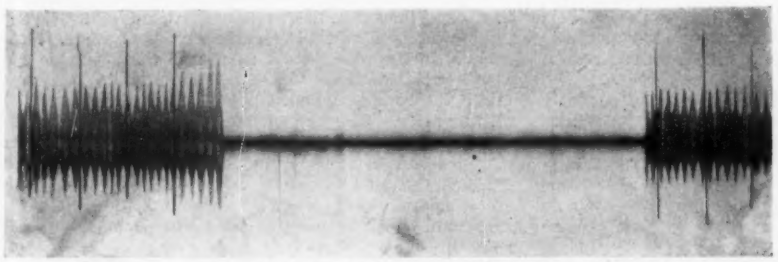
With proper training this difference disappears and the registers coordinate perfectly. The falsetto loses its false quality and becomes a part of the voice proper. The same applies between the "upper" and "chest" voices of a woman, the lower voice being capable of extension over the entire range for a loud note.

Contrary as it is to the usual opinions of musicians, the results of this investigation indicate clearly that any note may be started falsetto and swelled gradually into the "chest" voice, with no break between them. So completely is this true that the great singers, who happen to possess naturally the equipment which others acquire only by proper training, are accustomed to insist that there are no such things as registers. As a matter of fact, the existence of a register is nothing more than an indication of improper coordination and lack of development among the muscles that control the vocal cords.

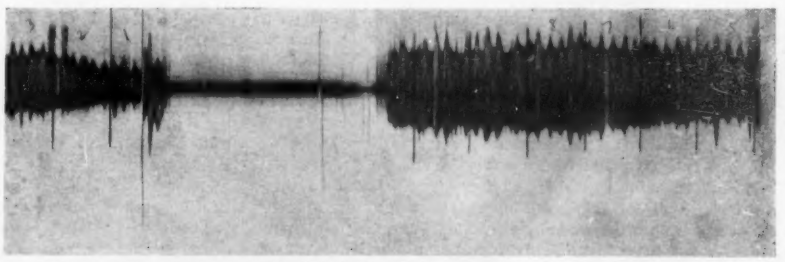
The transition from one register to the other—from the falsetto to the chest—involves the muscles that stretch the vocal cords and bring them closer together. There are three sets of these muscles; two, in particular, that have to do with the tension of the cords. To sing softly, one set of muscles predominates. To swell the tone the other set of muscles must be brought more and more into play.

Therefore, if one wishes to start a note in falsetto and swell it into a loud, strong chest tone it will be necessary to use practically only one set of the vocal-cord muscles in the beginning, and gradually to bring in the other set more completely while the tone is being sung. Unless the coordination of both sets of muscles is practically perfect this transition will be far from smooth. It may be impossible altogether. This is what makes the break between the falsetto and the ordinary

(Concluded on page 446)



An oscillograph record of the end of one tone and the beginning of another. The points and hollows on the curves indicate what musicians call a vibrato



Another oscillograph record which is much less regular in the shape and spacing of the vibrato peaks, indicating a voice that is less perfectly controlled

An experiment in telepathy, such as is described by Dr. Prince in this article. One person, who has been absent from the room and is blindfolded, attempts to catch by thought transference an idea of what the other persons are unitedly thinking about

Experiences Which I Cannot Explain Away

Are the Observations of This Noted Investigator Explainable by Mental Telepathy?

By Walter Franklin Prince, Ph.D.

Research and executive officer and associate editor of the American Society for Psychical Research and Chairman of the SCIENTIFIC AMERICAN Psychic Committee

THE pursuit of psychical research reveals three types of mind—that dominated by the will to believe, that obsessed by the will to disbelieve, and that which lacks any other predisposition than to determine the facts.

A favorite dogma of those owning the will to disbelieve is that every person who becomes impressed by evidence seeming to favor the occurrence of the supernormal is dominated by the will to believe. The SCIENTIFIC AMERICAN having asked me for a statement of the phenomena with which I have come in contact and which have impressed me as worthy of provisional acceptance—or which, if you prefer, impress me as impossible of rejection on the face of the evidence—I may perhaps be pardoned if I give first a few biographical details which are relevant only in so far as they tend to acquit me of this will to be too credulous.

I got my bent toward psychical research from a childish passion for solving puzzles of all kinds—mechanical, mathematical, verbal, literary. Disputed and doubtful handwriting engaged my attention and its problems fascinate me still. Later came historical puzzles, questions debated for decades or centuries. I have made original researches into the blue laws of New England and the early criminal code of Virginia. In both instances my findings, now generally accepted, were directly contradictory to what had been believed for many years to represent the facts. These facts are not remarkable but they testify, perhaps, to the absence of a will to believe, to the presence of a questioning, analytical, critical propensity.

When I was first attracted to the phenomena of psychical research, it was most emphatically *not* with a desire to accept them. When a very young man I fought spiritualism with ardor. I was still imbued with the belief that science had marked out the last boundary of the possible. At this time I shared in the delusion, which many people still carry to their graves, that the field of psychic phenomena contained nothing more perplexing than the average seance in a darkened room or the usual public test harangue. But as I pursued the subject, I found myself ever and again confronted by puzzles which the most careful and pertinacious study did not solve on any normal basis. Of course, I am still encountering constantly cases of fraud, of self-deception, of erroneous observation and inference. There are whole classes of alleged phenomena (independent writing, for example) which seem to me unsupported by trustworthy evidence. Others, among which I can cite psychic photography, seem to me superlatively doubtful. But there are other varieties of psychic experience which have refused, obstinately and tantalizingly, to be thus disposed of. They persistently present themselves in such fashion that I have not found any alternative to their acceptance.

One such category is the phenomenon of supernormal rapping. I had lived in twenty-six houses with no sounds or anything else to cause perplexity. Noises caused by weather, steam pipes, rats and mice, insects, wind, and the like are all familiar and all easily traceable to their sources. With my wife and daughter, Theodosia, I moved to my twenty-seventh house, located in the middle of a large lawn on a quiet street.

Many odd and unexplained things happened during our three years' residence in this twenty-seventh house. The rap phenomena opened with a grand display on a night when Theodosia and I were alone in the house. Twice she arose and searched the house, thinking that some living person or animal was moving about. At last she called me. I sat in her room for four hours, until morning, while she slept. Listening in the dark, in the two corners of the room opposite the couch I heard sounds much like the flopping of a wounded bird. With the light on, no bird was there. The sounds ceased when I went to the spot. At length the light was left on. The rapping continued. I heard forty to fifty percussions; a person with very acute hearing might have detected many more. What caused them? The girl was on the other side of the room and many tests left no doubt as to the location of the sounds. The weather was warm and there was no steam in the pipes. Rats, mice, cockroaches, wind? Conceivable, of course. But read on.

After that occasion the raps were heard frequently both by day and by night, chiefly the latter. Upstairs and down, in this room and that, in darkness and in light, when any one or two or all three of the family were present the raps occurred. Heavy sounds came in the piano but there was no detuning of any note to indicate a slackening of the wires. Raps came apparently upon the little table close to my bed in the room where I slept alone. Raps were heard by different persons in different parts of the house at approximately the same time. Raps came directly in front of me, on my dresser, as I stood beside it alone in the morning. Sometimes the raps were startlingly loud.

During a period when I was giving Sunday addresses none of these sounds occurred on Saturday nights. Did the rats or insects desire to protect my rest? By whom or what was this intelligent interest shown? It was not directly by the living persons in the house, the conditions shut them out entirely.

I have no answer, save that I failed entirely to find or guess any normal cause. Choose your own solution. Force proceeding from our bodies and directed by the subconscious mind of someone in the house; spirits; jinns; the cosmic mind; what you will!

A few weeks after the commencement of the raps in this house similar mysterious sounds began in my office. Generally they seemed to be on or in desks. Nearly always they occurred when I was alone. Twice only, on consecutive days, and when "psychical" persons were with me, sharp clicks were heard. Everyone located them at a certain spot on the glass bookcase.

Then the raps ceased in the house almost as suddenly as they had begun. They ceased, too, in the office but not contemporaneously. They occurred for several further brief periods; then ceased altogether. They were certainly in the room. With the exceptions stated they certainly appeared to avoid gatherings of persons. They were certainly without any relation to the weather.

Another phenomenon on August 11, 1920. I had my secretary and another lady sit with their hands laid lightly on a heavy table in my office, this being the first experiment of the kind with them. The electric light was brilliant. Presently raps came singly, in groups, in showers. I sat so that I could watch both above and below the table. No muscular force produced the sounds, which emphatically were not creaks of the table. The raps came at points suggested by me. They answered questions intelligently by the use of a code. When they sounded at one end of the table I asked them to go to the other. They proceeded by steps, ending with a click located by all beyond the table and on the glass of a projecting bookcase in the same line.

To crown all—shall I blush to confess it? I saw the table lift on one side and come down with a bang.

The hands were fully on top of it and lightly flexed. Knees and feet were within my sight. There was nothing to account for the phenomenon. Yet the same persons could never produce such a display afterwards!

Quite recently my attention was called to mysterious rapping sounds occurring in the office of an educated and puzzled physician. In automatic writing it was promised in my office that the "communicant" would try that night to make these raps come on the folding doors where they had not yet been heard. That night, the automatist of the writing being present (a psychic unconnected with the physician) the raps came upon that door as soon as we were seated. Following my requests they came upon another designated door, the floor and finally back to the folding doors. The next sitting was almost without results.

The phenomena of "supernormal" raps are, in my judgment genuine, but little understood as to laws and conditions, although apparently interfered with by turbulent emotions on the part of the sitters and by noisy conduct anywhere within hearing.

Another puzzling phenomenon is the deriving of impressions from an object held by a "sensitive" person, but with the character of the object concealed. I am convinced that some persons do, in a large percentage of cases, thus arrive at information regarding history of the object or the one who has handled it to a degree which is utterly beyond chance. What the underlying process is I have not the least idea.

Here is one illustration from many in my unpublished records. Into the hands of the "sensitive" was placed a letter in such manner that no word of it could be read. It had been taken from an old file. I knew who wrote it but not what letter it was.

The psychic's eyes rolled up and she went into an altered state of consciousness. She described the looks of a man—correct so far as she went—for the writer of the letter. She pictured him as lecturing to students then to a general audience. Both facts were true. A gesture was indicated—a thrusting out the arm while speaking (known to me as true) with two fingers extended (not known to me but found later to be an actual peculiarity). A big city, Boston, was envisaged. The letter was found to state that the writer had just been there. Another place spread out below a height; applicable to New Haven, also visited as stated within the letter. Then a church, longer than broad, an old church, a stone church, with a steeple, with a clock in the steeple, with stained-glass windows, a cemetery adjoining the church on the right, the stones in the cemetery all horizontal—every statement correct regarding the church over which the writer of the letter presides.

The speaker seemed to be standing in the cemetery, and saw lighter buildings back of the church, old but not so old as the church, a tree in front, two streets leading up from the opposite side of the church; also, directly in front of the church "what looks like an arch but isn't an arch." I afterwards found that if one stands where he sees the old (but not so old as the church), lighter tenement-house back of the church, the tree in front of the church and the two streets, he is directly opposite the porch and sees only its end pillars and supporting roof—hence what looked like but was not an arch. These were only two errors of minor grade; "lighter buildings" for "building," overestimation of the height of some of the horizontal stones.

The psychic lived in another city than that of the church. The clergyman was unknown to her. Not a word of help was given her, for I kept silence except for a question or two as I made the record.

The incident is injured by brevity of narration, but let the reader ask himself, for example, how many cemeteries he has ever seen adjoining churches and containing not a single stone which stands upright. A leading mathematician, A. S. Hawkesworth, F.R.S.A., has calculated the probability of getting these results by guesses as not more than one in five quadrillions.

There is evidence, too, for the reality of phantasms. As the result of the analysis of a large number of cases by Gurney, Podmore and Myers, the last-named announced: "Testimony proves that phantasms (impressions, voices or figures) of persons undergoing some crisis—especially death—are perceived by their

Houdini, noted magician and psychic investigator, posed at the grave of William H. Mumler, who was first to produce psychic photographs

friends and relatives with a frequency which mere chance cannot explain."

My own investigations agree with this statement. For example, a lady not given to such experiences, had one afternoon in her New Jersey home a vision of her foster-brother and her father and told her sister and mother about it at once. After the return of the brother from the war, he told "the most wonderful experience" of his life, which was that when a torpedo was approaching his ship in the North Sea he saw his deceased father beside him on the deck. The day of the two experiences was the same. It was at least very close to the same hour. The signed certificates of the four persons are in our possession. Too many indisputable cases of this kind exist for them to be explainable by ordinary causes.

Another phenomenon—that of telepathy or thought transference—is not generally recognized by scientific men, as many suppose that it is. But the reason is that the scientists will not study the evidence. It is conclusive, so far as I know, to all scientific psychical researchers.

One of the most successful "sensitives" along this line is no less a person than Professor Gilbert Murray of Oxford University, a former president of the Society for Psychical Research. Here is one example from a set of experiments presided over by the accomplished and experienced Mrs. Verrall.

Professor Murray left the room and an imaginary incident was arranged by the four persons remaining, as follows: "Mr. S. playing Badminton at the Badminton club at Bogota. Lord Murray watching. Ladies watching, one with a fan." Mrs. Toynbee was the ostensible "agent." Professor Gilbert Murray was called in, and this is what he said: "This has something to do with your voyage to Panama (Mrs. Toynbee had made such a voyage)—it's South America—its people are in white playing a game—it's your villain S——; he's playing a game—the word Bogota is coming to my mind—I think it is at a games' club." Mrs. Toynbee asked, "What is the game?" "I think," the professor replied, "I am only guessing. But I think the game is Badminton, and the Master of Elibank (Lord Murray) is there."

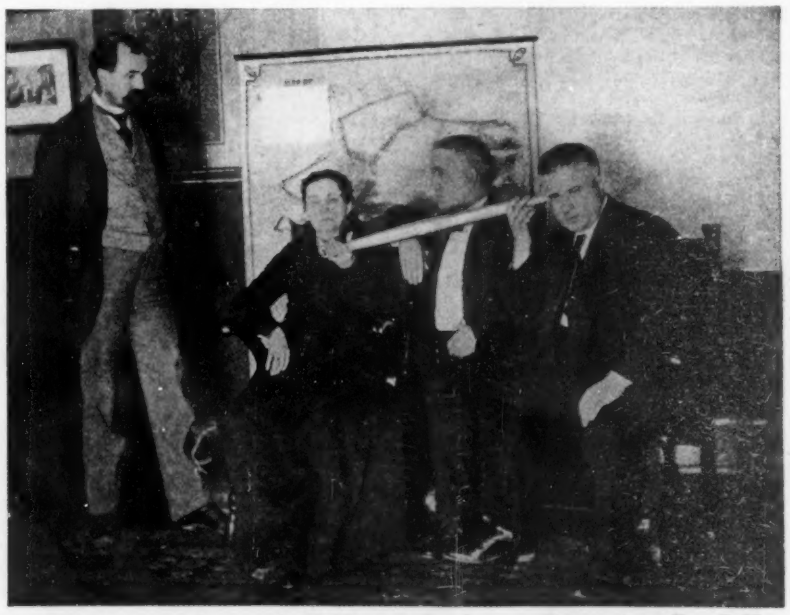
Now take into consideration that the incident was wholly imaginary, so that one known particular could not bring on other particulars in a known incident, and will you venture to say that this peculiar coinciding combination came about by chance? Every prearranged detail except the fan appeared in the result. Nothing was added except the white clothing, which probably *was* a part of Mrs. Toynbee's mental picture of a group of society people playing a game in South America. The Society for Psychical Research reports a great many correct results by Professor Murray, some quite as complex as in this case.

Are there such things as premonitions? There is at least impressive evidence for them. I myself—shall I blush to say it?—have had exactly four dreams in my life of such vividness and such fearful intensity of emotion that they stand out in my memory as real occurrences. Three of these were coincidental, while I do not recollect that I ever had any other dream which attracted my attention because of coinciding factors which were at all impressive.

In one of these four dreams I saw a woman who had brought to the place her own death warrant, written in the color of blood. She remarked, "I am not afraid to die but will you hold my hand? She took my hand and I felt its firm grasp as the light went out and it became dark. Then I became conscious that her head was removed from her body and I felt the wet blood upon her hair. Then her teeth opened and shut gently several times upon my hand. I woke with the gruesome feeling that the head was still living after separation.

I told this dream to two persons whose testimonies I have. On the next day but one the particulars which coincided appeared in the papers. A few hours before my dream a woman disappeared from her New York home in a demented condition. About twenty-four hours after my dream, at midnight, she laid her neck upon the railroad track about six miles from my home. Her head was cut off as clean as if by a hatchet. The

How table tipping is done. Dr. Prince once saw a table rise in an experiment like this under brilliant illumination



Dr. Hyslop (standing at the left) and the famous "trumpet medium," Mrs. Blake, who was the subject of many investigations.

Miss Theodosia B. Prince, known in psychic literature as "Doris," formerly the most remarkable case of multiple personality ever investigated. An example of her automatic writing is given below

death was voluntary. She went to her place of execution, it took place in the dark, her name was "Hand" the word which most frequently appeared in the imagery of my dream, there was found by her body a letter which said that her head would be living after it was cut off. These are the facts, make of them what you will. This dream may possibly have been a telepathic one, but what of another?

On January 8, 1902, (1) a train was standing in a tunnel in New York City; (2) with the rear end protruding; (3) another train dashed into it; (4) by a head-on collision; (5) the wreckage was piled up and a number of deaths and injuries resulted; (8) then men came and cut away at the wreckage to free the victims; (6) then scalding steam broke out in volume; (7) more disaster to human beings resulted from this cause. Attention is called to the order in the details.

About four hours *before* the real accident I dreamed all the particulars exactly as above related with fearful vividness and stress of emotion. For fully fifteen minutes after my wife awakened me I still seemed to hear the shrieks of anguish and the hissing of the steam. I remember the whole today as if it had been really witnessed.

Was *this* telepathy? It could not be. Was it chance? If so, will someone explain to me the law which caused my three proved coincidental dreams to occur in the group of four out of a lifetime marked by specific qualities of vividness and emotionality? Of course I am much ashamed of having had such dreams, but having had them would like to know what to do with them. Shall I admit that there is "something in" the "Hand" one, on the basis of telepathy? Then am I to rule out that of the collision, where the coincidences are just as pronounced, since it cannot have been of telepathic origin?

Mediumistic Messages. We are told that these are all contemptible, trivial, unevidential, by those who will not study the facts or discuss any case upon which we place emphasis. The fact is far otherwise.

My foster daughter, "Doris," was formerly one of the most extraordinary examples of multiple personality —a phenomenon which all psychologists recognize—ever studied. Five months after she had attained normality Dr. Hyslop brought her from California as a subject of experimentation with his psychic, Mrs. Chenoweth of Boston. Well known as the case is now, no line had then appeared in print about her. She had never lived within 500 miles of Mrs. Chenoweth, and there was no possible opportunity of leakage of facts about her. Dr. Hyslop himself knew almost nothing of her early life. The medium was never told whether a man, a woman or a child was to be the next sitter, and was always put into a trance before the sitter was brought in. Doris, selected out of a hundred millions and brought 3,000 miles, sat down behind the medium and was not allowed to speak. Every word uttered by Dr. Hyslop is a part of the record. The automatic writing began, and the very first which was written was "John E.," the name and initial of her living father. Anything remarkable about that? Not if it were simply John, but John E. is a very different matter. There are twenty-six letters in the alphabet, and anyone of them may be coupled with any one of many names. Presently the mother, really deceased, professed to communicate, and in a half dozen sittings poured out facts correctly related to the daughter and to herself, and which would not have been true as related to any other of her children. The mother's name was given, "Emma," and the sitter's very peculiar real name, Brittia, was written as nearly as "Bretia," and pronounced orally by the medium as the family pronounced it, "Britta." Besides the facts and incidents given there came many passages describing the very singular conduct of the daughter growing out of its psychological character, but with no hint of understanding of the "multiple personality" explanation; the description was in terms of conduct, exactly as it would have been if the mother had been living, and was photographic in fidelity, so far as it went—and it went pretty far. Suddenly there was interjected a message purporting to be from Dr. Richard Hodgson, which at once stated that this was a "case" like one which he had known, named Dr. Morton Prince as the man connected with the other case, and then named the case—"the Beauchamp case." Now it *happens* that the Beauchamp case is the nearest known prototype to the afterwards published Doris case, then utterly unknown. Dr. Hodgson had personally known the Beauchamp case in his lifetime. But Doris was now splendidly healthy and normal-appearing. Even if the medium had been able to see her and converse with her she could never have suspected that there had been anything unusual with her. There was not one chance in many millions of such a thing being said of an unseen and unknown sitter and being correct. And yet this, and nearly all others of about a hundred statements of facts purporting to come from the mother and Dr. Hodgson were true of this girl. Suppose I cited just ten statements (including the one just referred to) which every intelligent person would say had not one chance in twenty of being correct by guess, taken separately; then seeing that they are selected so that none of them implies another, what chance had they of being correct in combination? One chance in 10,240,000,000,000. I assure the reader that the rest of the facts, though not all were correct, do not subtract from, but rather add greatly to the tremendous odds which the doctrine of guess would have to face in this case, as my little book now in preparation will show.

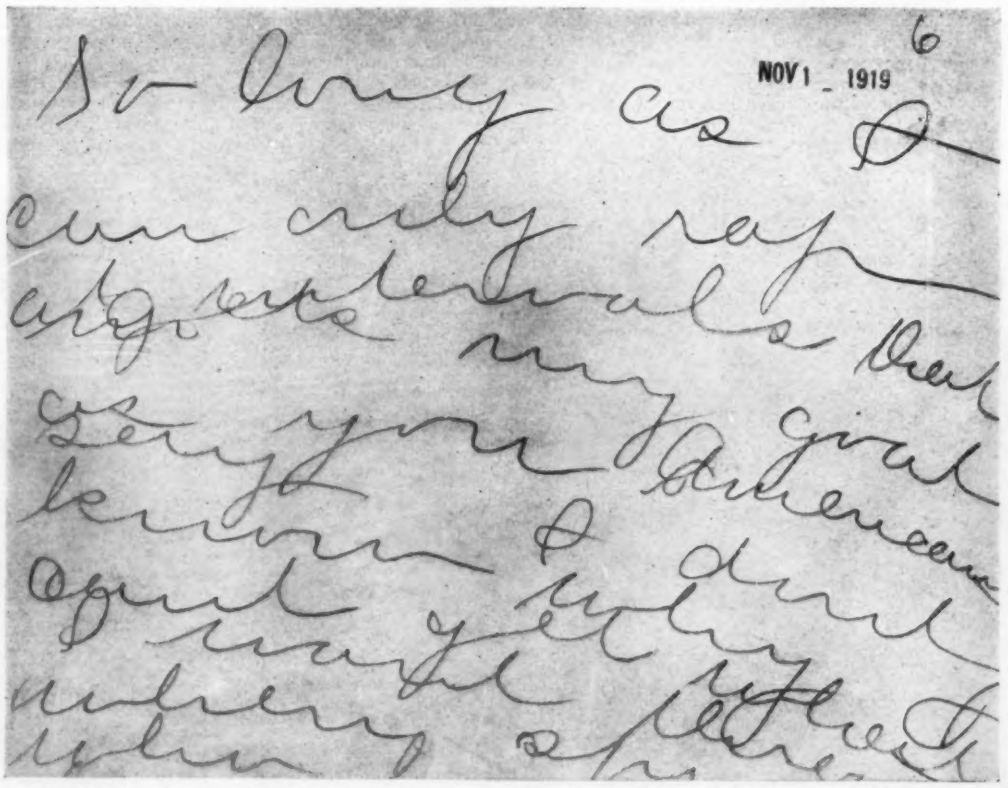
My psycho-analytical friends have said that if they could analyze Mrs. Chenoweth—one stipulated "for six months"—it would be probably found that all these utterances were based upon experiences of the medium herself. And I do not doubt that they could find that she once knew someone named Emma—most people have; that she was fond—or the reverse—of a John*nie*, which fact might suggest "John E." The various particulars regarding conduct might be ingeniously spliced together out of details regarding various odd children whom she had known; and perhaps there might be found some complex regarding "Bert's ear" or a pair of breeches which might be supposed to give foundation for "Bretia" and so on. If given "six months" I could contrive to find combinations myself. But how would all this help as an explanation of the literal and amazing correspondences with the past of the girl who was the sitter? Granted that the medium had been greatly interested in reading about the Beauchamp case; that would not make easier the puzzle of how her automatic writing came to declare that an unknown and unseen sitter picked out from the population of the United States was a case of the same sort, when all her voluminous scripts in possession make no such remark concerning any other sitter.

A friend of mine well known to the public because of his incessant attacks upon every claim to the supernormal, the evidence of which he disdains to study, told me that the case I have just sketched might not carry its clues on its face, and he had not time to search for them. I who have studied these matters forty times as much as he, and have unearthed a host of frauds and delusions by my own analysis while he has depended for his solutions mostly on the efforts of others, tell him that I *have* taken time to study this case as thoroughly as any other, and that it does not carry its clues on its back, either.

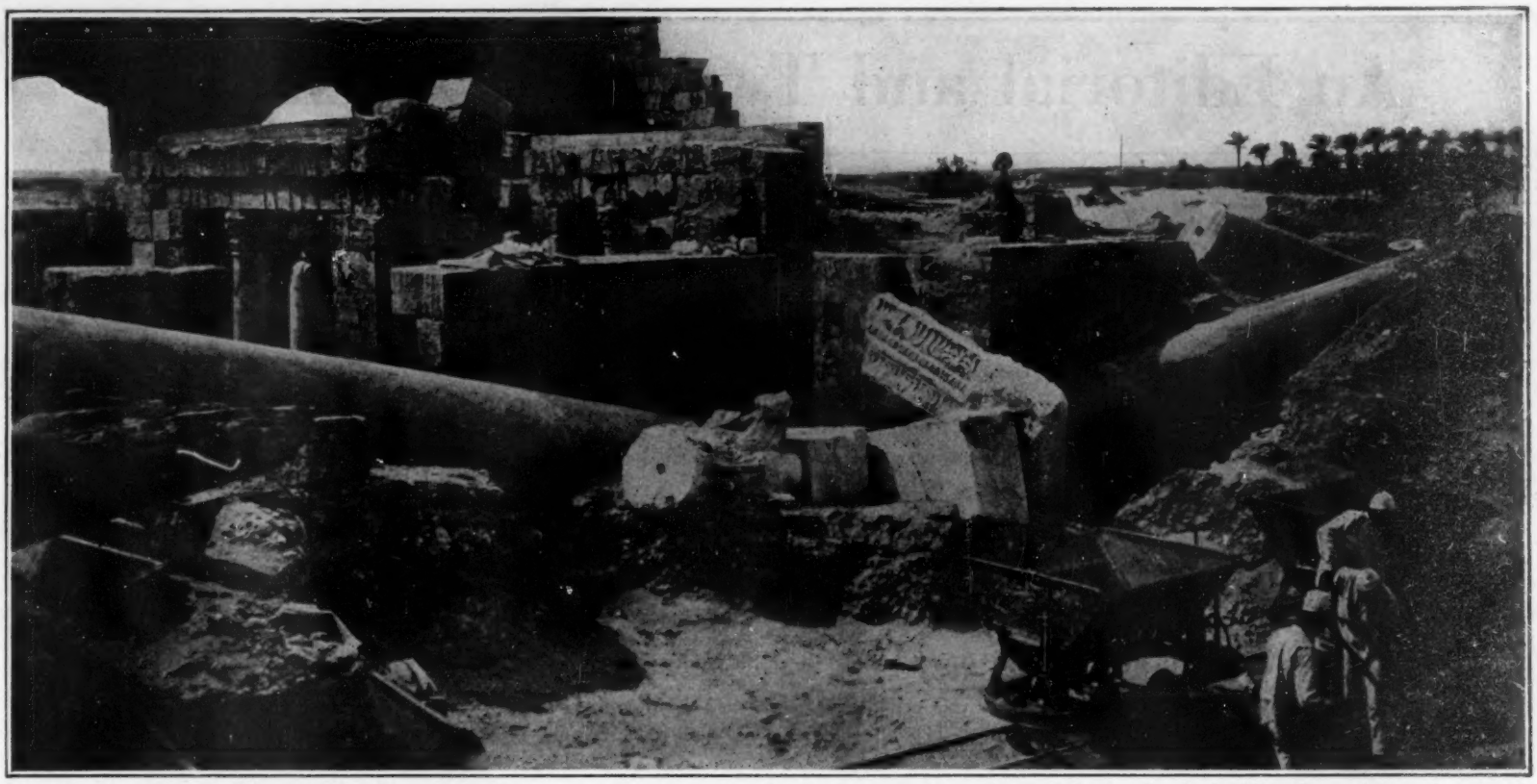
Another eminent sceptical gentleman publicly accepted my invitation to attempt an analysis and explanation of the same case, on a "normal" basis. He has had the documents in hand for more than three years, and I am still waiting.

In an article of this length, covering a number of types of phenomena, I can give only hints of the nature and volume of facts which exist. There is not space to discuss theories, particularly in reference to the mediumistic type; but I am far from satisfied that telepathy is the universal solvent. In two printed cases, I think that I have fairly demonstrated that, against great odds as to chance, facts unknown to any living person were revealed.

The scope for illusion, that prevalent source of error where physical phenomena are in question, is small in phenomena of a mental type, and can be completely eliminated by a correct methodology. In spite of all fraud and delusion, all hasty inference and possibilities of chance, and in spite of all the vagaries of devotees and credulities of would-be but ill-equipped investigators, there remain like boulders in the field of psychical research facts which will not yield to the scrutiny of the detective, dissolve in the acid of the critical analyst, or crumble under the blows of the logician.



A reproduction of an actual sheet of automatic writing obtained by Dr. Prince through "Doris" and referring to the raps which he describes in this article



General view of Leptis Magna looking toward the Thermae, or Roman Baths. In the foreground are three of the two hundred-odd arab convicts now engaged on the work of excavation

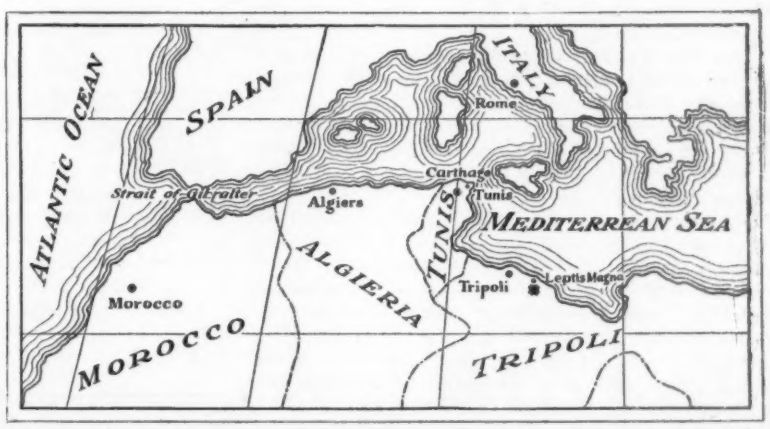
How Important Is Leptis Magna?

Dr. Bruno Rosselli, Professor of the Italian Department at Vassar College, recently set scientific circles astir by his account of the discovery and excavation of the lost city of Leptis Magna—one of the most important developments in the field of archeology during recent years. With perhaps over-much enthusiasm, the first reports were heralded as a startling development which far exceeded in scientific value the exacavation of Pompeii.

Leptis Magna *is* important but it is hardly fair to compare it with the famed Pompeii, because the former will probably contribute to archeological knowledge a fund of information along entirely different lines than that which has already been gleaned in Pompeii. As Professor Rosselli points out, Pompeii was a provincial city which was buried almost instantaneously and in toto. The city has therefore yielded a mass of valuable data on the life and manners of the times. Leptis Magna on the other hand, was an imperial city built (A. D. 175-200) by Septimius Severus, a Roman emperor who was himself a native of the town.

Architecturally, Leptis Magna is magnificent. The imperial palace, the baths and the docks bear evidence on this point although the Thermae, or roman baths are the only buildings which have actually been excavated down to what was once the street level of the ancient city.

This city was built and buried in sand during a mysterious period in history about which there is little authentic information. It appears likely therefore, that much of direct historical value will be found in this city which has been buried and preserved in sand for so many centuries. The original excavations were begun by Prof. Bartoccini during the winter of 1923.



Map showing the location of Leptis Magna—about 100 miles east of Tripoli

The docks at Leptis Magna once the waterfront of Rome's granary. They are the most perfect examples of Roman walls in existence and the only examples which have come down to us through the centuries without change

The lettering over the main entrance to the imperial palace at Leptis Magna reads, "PERATOR CAESAR LUCIUS SE" which conclusively proves that it is the palace dedicated to Septimius Severus, a roman emperor born in Leptis Magna

An Editorial and Two Announcements

Lessons From a Tragedy

AT THE Dayton air meet of 1924, the airplane piloted by Captain Burt E. Skeel of the Army, apparently disintegrated in the air just as the Captain was beginning the race for the Pulitzer speed trophy. The fragments of the airplane and the body of its pilot were driven deep into the soil of the aviation field, which is located upon ground that was once a quicksand.

It is difficult to be sure just why this accident occurred. Reports of eye witnesses agree that the airplane came partially to pieces. One wing or a part of a wing was detached while the airplane was still in the air. The question is why this happened.

In the beginning of a race for high speed it is the custom to climb high into the air, make a sharp dive and then flatten out just before crossing the starting line. Thus the speed accumulated on the dive gets the ship off with a speedy start on the race itself. This plan was being followed by Captain Skeel.

It is conceivable, therefore, that the strain put on the wings of his airplane by the sudden flattening at the end of his dive may have been too much for the wing structure. But this is unlikely. Some witnesses report that the ship seemed to come apart *before* its course had been flattened out. Furthermore, the fact that the fragments hit the ground with such tremendous force argues for a much higher speed than would be attained by mere free fall after the ship had disintegrated. Everything indicates that the ship came apart, for some reason, while it was still in its downward dive toward the starting line.

The most probable cause for such an accident is a failure of the propeller. On a steep dive the propeller ceases to be an airscrew driving the airplane. It becomes a windmill revolved by the speed of the airplane. It may attain a speed much greater than that for which it was designed. It drives the engine instead of being driven by it.

Some of the fragments of the propeller picked up after the Dayton crash are reported to show splits along the laminations of the wood, instead of crosswise breaks. Such evidence must not be over-emphasized but it reinforces the conclusion drawn from other evidence, to the effect that the propeller pulled apart because of the centrifugal force due to the high diving speed. This unbalanced the engine. The consequent vibration literally shook the airplane apart.

Two questions arise. Why was a wooden propeller used instead of a metal one? Is it worth while to attain high-speed records by the dangerous expedient of high diving at the start? Doubtless there is a satisfactory answer to the first question. It is hard to see any answer to the second question except a negative one.

Records or Utility?

THE Dayton tragedy reinforces a conclusion which is becoming more and more apparent to those who follow the progress of aviation. It is this. The striving for greater and greater speed records has gone far enough.

At the beginning of the war the maximum speed of airplanes was about 100 miles an hour. By 1919 this had climbed to about 150 miles an hour. Then came the offering of the Pulitzer trophy and the records began to climb again. Last year at St. Louis, Lieutenant Al Williams flew at a speed of more than four miles a minute over the 120-mile course. These records are made with airplanes built solely for speed. Everything —even, one fears, the safety of the pilot—is sacrificed to that single end.

There is no doubt that speed records can be still further increased. Even if the rules be altered to prohibit the superlatively dangerous initial dives like that which killed Captain Skeel, much greater speeds than any present record will be, not safe, but possible. Certain improvements of design that are already evident will help this. The biplane wing will give way, in speed tests, to the cleaner monoplane. The retractable chassis is already in use on some designs of high-speed ships. The wing may be designed so that its cross-section can be changed in the air, opposing a very thin profile after the ship has attained a relatively high speed. Records of 300 miles an hour or even more seem quite within our reach.

But are these worth while? May it not be a better policy, even from the military point of view, to delay further speed development of the fast racers and to allow the slower fighting ships—already at 180 miles an hour for single-seat pursuit airplanes—to overtake the development of the racer?

It is a common charge that American aviation, while obviously successful in securing speed records and in developing fighting qualities, has lagged seriously behind Europe in the perfection of commercial craft. This charge is not really justified. At the Dayton meet more than 200 airplanes flew in from other airports carrying visitors to the meet. There were only two or three forced landings. A Stout airplane flew from Detroit with a pilot, mechanic and six passengers. This does not look as though America were as utterly lacking in commercial aircraft as some writers would have us think.

Nevertheless, the development of the commercially useful qualities of comfort, safety and dependability has unquestionably lagged behind the development of speed. Let us have some outstanding reward like the Pulitzer trophy to honor and to encourage the accomplishments of the commercial ship.

An Announcement

BY CONSIDERATIONS like those outlined in the preceding paragraphs the SCIENTIFIC AMERICAN has been induced to inaugurate a new department. It will be a department of the use of aircraft. In this department, the first installment of which will appear in our January issue, we will present the news, the prospects, the hopes of the pilots and designers who are helping to make aircraft useful.

The department will be conducted by Professor Alexander Klemin, Associate Professor of Aeronautics at New York University.

The Eclipse Investigation

Many enrolments have come in for the radio investigation of the total solar eclipse of January 24, 1925, as announced on page 312 of the SCIENTIFIC AMERICAN *for November. A few more are needed.*

If you are willing to listen to special signals which will be broadcast for about thirty minutes during the eclipse and to report what you hear, you may assist us to determine the mysterious effects of the sun on radio transmission.

Write us now and enroll. Be sure to send us ALL of the following information:

1. *Your name and mail address.*
2. *What is the make and design of your radio receiver?*
3. *What kind and size of antenna do you use?*
4. *Do you use storage batteries or dry cells?*
5. *Are you located in open country or in town?*
6. *How long have you been a radio fan?*
7. *If you have an amateur license will you be willing to send signals if we ask you to, instead of listening?*

Address:

The Eclipse Editor,
SCIENTIFIC AMERICAN,
233 Broadway, New York, N. Y.

Full instructions will be sent you later and will be printed in the SCIENTIFIC AMERICAN *for January, 1925. On page 379 of the present issue there is some account of the public observations asked by the American Astronomical Society. These, too, we will describe in detail in our next issue.*

Another Announcement

ON THE opposite page is an account of what may prove to be one of the most revolutionary discoveries of all time. The economic revolution — often preached, more often feared—will never come about through soap box oratory. It may result either from a flood of cheap gold or from the discovery of some way to tap atomic power. Both of these possibilities are bound up with investigations of atomic transmutation, like those reported by Professor Miethe and which we are now repeating in the United States.

The field of atomic science has been characterized in the past ten years by some of the most remarkable and far-reaching discoveries that science has ever made. The SCIENTIFIC AMERICAN intends to keep its readers abreast of the progress of research in this realm of the tiny but marvelous atom and electron.

Atoms are so small, you remember, that millions of them can lie side by side on a pinpoint. Electrons are smaller still.

Criticizing Professor Einstein

IT MAY seem a far cry from the tiny dimensions of the atom to the vast astronomic dimensions contemplated by the Einstein Theory of Relativity, with its bending of light rays by a foot or two in a billion miles and its universe that curves back at some vast distance, upon itself.

But actually the Einstein Theory and atomic physics are never far apart. The mathematical formulation of the Relativity Theory has been of the greatest aid in the elucidation of atomic structure. Conversely, the best evidence that exists for the essential correctness of the Einstein theories lies, it seems to us, in the field of atomic physics and not in the field of astronomy.

It is perhaps fortunate for the ideas of Professor Einstein that this atomic evidence exists. During the past year there have been two vigorous attacks on the Einstein point of view; one by Professor T. J. J. See, of Mare Island, California, the other by Professor Charles L. Poor of Columbia University. Both have been based mainly on doubts of the astronomical evidence.

Among the famous three proofs of the Einstein theory there were two that were astronomical; the proof from the deviation of light rays that pass close to the sun and the proof derived from the slight irregularity in the motion of the planet Mercury, an irregularity left unexplained by the ordinary, Newtonian theory of planetary motions. Professor Poor attacks both of these proofs. Professor See confines himself, in the main, to the first of them.

Professor See's attack can be dismissed in a word. He believes that Einstein's mathematical calculations are wrong. In fact it is See that is wrong. The best mathematicians in the world have repeated Einstein's calculations. They are unquestionable.

The argument of Professor Poor is a much stronger one. He points out that the deviation of the light rays past the sun is a very difficult matter to measure with accuracy and that the data obtained are susceptible to other interpretations. This is undoubtedly true. As to the irregularity of Mercury, Professor Poor suggests that it is equally well explainable by the assumption of some distributed matter in space, an assumption for which there is much other evidence.

But the great strength of the Theory of Relativity does not lie in these two supposed astronomical "proofs." It lies in its successes in atomic physics.

For example, Dr. Sommerfeld, of Vienna, used the Einstein equations of motion to work out the orbits of the electron particles in an atom of hydrogen. From this he predicted what would occur in the light spectrum given out by glowing hydrogen. It did occur. This is only one instance out of many.

Why We Are Trying To Make Gold

FOR more than three hundred years the best scientific minds of the world—for the ancient alchemists were, in their day, the very flower of science—strove without cessation to make gold out of some baser metal. They failed. The mysterious "philosopher's stone" of which they had read in still more ancient books and which was believed to have the power of turning everything into gleaming gold, this magic talisman persistently eluded all search. Finally the sensible men of the world grew gradually to believe that all this effort was useless. Alchemy fell into disrepute.

And now, after another two centuries, the secret of making gold seems to have been discovered by accident. Where the labor and intelligence of so many thousands of alchemists came only to failure, a German college professor seems to have succeeded by absolute luck. His magic wand is not any mystic stone of the philosophers; it is the more modern magic of electricity.

This, at least, is what most of the scientists of the world are now inclined to believe as a result of the remarkable observations recently published by Professor Adolf Miethe of the Charlottenburg Technical College, near Berlin, and mentioned briefly in the SCIENTIFIC AMERICAN last month.

Professor Miethe was not searching for the philosopher's stone; far from it. He was engaged in researches on ultra-violet light. To procure this light in sufficient intensity he employed a quartz lamp containing the vapor of mercury, the liquid metal familiar to everyone under its other name of quicksilver. The vapor of mercury was contained in a bulb made of fused quartz. Through this vapor there was passed a powerful current of electricity. After a time Professor Miethe noticed that the inside of the quartz bulb had become coated with a black film. He analyzed this film. It proved to contain gold.

This was astonishing but it might be accidental. The professor started afresh. He got some new mercury and carefully purified it. He divided it into two portions. One portion he placed in his quartz lamp and then ran the lamp for two hundred hours. On analysis gold was found in the mercury that had been in the lamp; no gold was found in the other portion of the same mercury, the portion that had not been exposed to the electric current. The lamp itself was then taken apart and analyzed. No gold was found in any part of it. The conclusion was inevitable that a very little gold had been created somehow during the operation of the lamp. Presumably it came from the conversion of a few of the mercury atoms into atoms of gold.

That is where the matter stands as these paragraphs are written. Admittedly the experiment needs confirmation. But Professor Miethe is a scientist of distinction. His precautions seem to be adequate. There is not the slightest question of his honesty. On the contrary there is every reason to believe that he has actually done what he thinks that he has done. It is probable that the secret of the philosopher's stone has been found.

If this is true it is one of the most important scientific discoveries ever made and not all of its importance is scientific. Gold is not only beautiful and scarce and valuable; it is also the basis of modern finance.

When you pay a bill with a check you use a piece of paper the actual value of which is nothing. Your creditor accepts it because he knows that he can take it to the bank and get money for it. Even the money that he gets at the bank is likely to be paper money. If so, it is, in reality, as valueless as the check. The acceptability of a banknote in ordinary business rests upon the knowledge that such a note can be taken to the United States Treasury and exchanged, under proper terms and conditions, for the only real money in the world, that is, for gold.

The entire vast structure of modern business is built upon a metal and a fact of psychology. The metal is gold. The fact is that men all over the world believe that gold is valuable.

Now suppose that Professor Miethe or someone of his successors is able not only to make gold but to make it cheaply, so that gold becomes as common as iron or portland cement. We could build our houses of gold, which would be both beautiful and useful, for gold does not rust. But it is extremely unlikely that many of us would have funds to build houses with or would be alive to live in them if we had.

A sudden destruction of the belief that gold is valuable would wreck the fabric of business in a day. Starvation, war, pestilence would not be far behind. The modern world is a business world. Wreck business and the world goes with it. Cheap gold, suddenly acquired, would wreck civilization far more surely than all the panics and thieveries and wars of history.

Why, then, has business survived without even a ripple the announcement of Professor Miethe's discovery? Merely because his process is not cheap. It costs him thousands of times as much to make his gold from quicksilver as it would to go and buy some gold in the nearest jewelry store.

What We Hope To Do

Professor Adolf Miethe, of Berlin, reports that he has converted quicksilver into gold. The SCIENTIFIC AMERICAN *is now arranging for the repetition of this experiment.*

If the transformation of quicksilver into gold is confirmed, we will endeavor to discover exactly what conditions control the conversion.

We will obtain data for an estimate of the cost.

We will make the best possible estimate of the time—if ever—when the world will have to face the threat of cheap gold.

We will communicate the results of this investigation to the public unless, as a matter of public policy, it seems wise to delay their publication.

But this expensiveness of the method may not be inevitable. Most things cost a great deal when they are first discovered. The original electric lamp cost, it is reported, more than a thousand dollars. Now you can buy a better one for thirty cents.

The important fact, therefore, about the gold-making process of Professor Miethe is the possibility that it may be cheapened. Fortunately this is not likely to happen suddenly and it is only a sudden flood of cheap gold that constitutes a threat to business. If the destruction of gold values can be foreseen it will not be a menace. We can shift the basis of world credits to something else; for example to the "commodity dollar" suggested some years ago by Professor Irving Fisher, a monetary unit the value of which is determined by the average market value of a number of basic commodities like wheat and coal and steel.

The great need of the present situation, therefore, is more facts. Does the Miethe process really make gold? Exactly what does it cost? What are the prospects of cheapening it? Can we expect ever to make gold more cheaply than we can mine the natural gold from the earth? How soon, if ever, can we expect such cheap gold to be available?

Given these facts the governments and financiers of the world can prepare for whatever is probable. They can take steps to control the gold-making process if that is possible. Or they can prepare the structure of finance for an easy transition to whatever other standard of values seems necessary or most desirable.

Considerations like these have impelled the SCIENTIFIC AMERICAN to organize a careful repetition of the Miethe experiment in an American laboratory. Arrangements have been made for the cooperation of Professor H. H. Sheldon and Dr. Nicolas Rashevsky of the Washington Square College of New York University, two distinguished physicists already well known to readers of the SCIENTIFIC AMERICAN. The SCIENTIFIC AMERICAN is supplying funds and is lending all of its own facilities to the work. The object of this work is not merely to make gold. It is to discover *what it will cost to make gold.*

Mere artificial gold would have tremendous scientific interest; it might be useful in many ways in scientific experimentation; unquestionably the process would give us deeper insight into the many unsolved problems of atomic structure. But these things, interesting as they are, are not the impelling motive of the SCIENTIFIC AMERICAN. What does impel us is the duty of foreseeing, so far as may be possible, what is likely to happen to gold as a medium of exchange and a standard of financial values. That is what we hope to discover; what we hope to be able to make public in future issues or to communicate—if it seems that secrecy is necessary—to the leaders and directors of the world's finance.

A sudden debacle of values based on gold would be a world misfortune beside which wars and earthquakes and the Black Death are mere mild annoyances. The one thing that will surely prevent such a debacle is advance knowledge of its imminence. That advance knowledge the SCIENTIFIC AMERICAN believes it its duty to provide if it be humanly possible to do so.

What scientists have learned in recent years about the structure of the atom provides a sound theoretical basis for Professor Miethe's claim of the conversion of mercury into gold. It is now believed, you remember, that the atoms of all chemical elements are composed of two kinds of electric particles; negative particles called electrons and positive particles called protons.

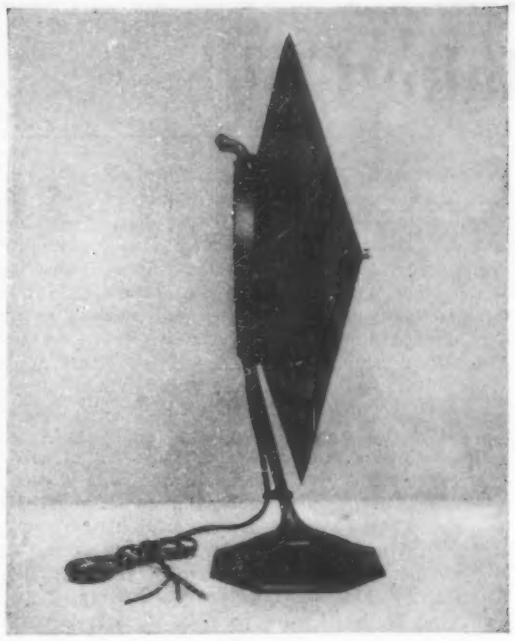
All of the protons and some of the electrons in any given atom are believed to be concentrated in what is called the nucleus, at the atomic center. This nucleus plays in the atom the same role as the sun does in our solar system, it holds the atom together. Around this nucleus revolve the remainder of the electrons, just as our earth and the other planets revolve around the sun.

In the atom of gold there are 79 of these planetary electrons and in the atom of mercury there are 80 of them. That is, if you could knock one electron planet permanently out of the mercury atom you would have an atom of gold.

It is easy to knock out this one electron temporarily but that does not do any good. The electron comes back again. It is believed that to knock out the electron permanently we must alter the nucleus of the mercury atom, we must give it a lessened electric attraction so that it will not hold more than the 79 planetary electrons which characterize the atom of gold.

There are two ways, theoretically, in which this might be done. One way is to remove from the nucleus one of the positive particles or protons. This would decrease the electron-attracting power of the nucleus by one unit and make it able to hold only 79 planetary electrons instead of 80. The other way is to *add* to the nucleus one electron, thus neutralizing internally one of the available electron-holding units of the nucleus. This would affect the number of external electrons as before, decreasing it from 80 to 79.

Readers of the SCIENTIFIC AMERICAN will be hearing more about these atomic changes as our experiments proceed and as we are able to publish the results. In the meantime it is interesting to consider whether the ancient alchemists, so thoroughly discredited for so long a time, may not have made gold after all. Many of them claimed to have done so. A number claimed to have done so from mercury. Possibly they really did.



Our Radio Page

Listening-In on the Latest Progress of the Broadcasting Art

Loudspeakers of Today and Tomorrow

ONE of the anomalies of popular radio is that a five-dollar pair of ear phones will produce better music than a fifty-dollar loudspeaker. Indeed, dyed-in-the-wool music lovers who have finally succumbed to the musical charms of a radio receiving set have for the most part steadfastly stood by ear phones and refused to consider the loudspeaker.

The popular conception of a loudspeaker is that of any sound-producing device equipped with a horn and used in conjunction with a radio receiving set. Thus, we find all kinds of horns used with radio receiving sets and ordinary telephone receivers. One or both telephone receivers are connected with the horn so as to project the sounds into the room and do away with the necessity of clamping the receivers to the ears. In some instances one or both telephone receivers are clamped to the usual phonograph tone arm, so that the phonograph horn may be used for projecting the radio music or speech.

Devices of this kind are not to be considered in the same class as loudspeakers. They are merely improvisions or make-shifts. The usual telephone receiver is designed to produce sufficient sound for use as an ear phone. The vibrations of its diaphragm are just sufficient to vibrate that amount of air which is trapped between it and the ear drum when the receiver is worn in the conventional manner. In order that the same receiver may work with a horn, it is necessary to increase the amplitude of the vibrations—the stroke of the diaphragm, so to speak—and in this manner a greater volume of air is set vibrating so that sounds may reach the distant ear of the listener. Thus, we overload the receiver, with the result that its diaphragm strikes the pole pieces of the solenoids or bobbins inside the case, and some distortion is bound to take place.

The Three Classes of Loudspeakers

FOR real loudspeaker results—sound volume comparable with the conventional phonograph—it is necessary to use one of the three classes of real loudspeakers. For the purpose of ready identification, standard loudspeakers may be divided into three broad classifications, namely: First, loudspeakers of the plain electro-magnetic type, which are merely modified, standard telephone receivers, and which operate on the output of the standard two-stage audio amplifier; secondly, the electro-mechanical type, in which the magnetic pull of the solenoids or electro-magnets is not applied directly to the diaphragm, but instead is applied to a member known as the armature which, in turn, transmits the mechanical equivalents of the varying magnetic pull to the diaphragm through a series of levers and links, thus supplying mechanical amplification; thirdly, the electro-dynamic type, with its powerful magnetic field in which is placed a movable coil through which flows the audible current, and which is connected with the diaphragm.

The plain electro-magnetic type is by far the most common today. It is practically an outgrowth of the table-talker, with a more powerful telephone unit and usually some means of varying the air gap between the pole pieces and the diaphragm. The ability to vary the air gap is highly desirable, since, with powerful signals the air gap must be increased so that the diaphragm, now greatly flexed, will not strike the pole pieces and cause a hum or chatter, while with weak signals, the air gap must be reduced to a minimum so as to conserve the weak magnetic variations.

In the electro-mechanical type of loudspeaker we find a more intricate form of construction for transferring the electro-magnetic pull to the diaphragm. The electro-magnets or solenoids actuate an armature, which in turn operates the diaphragm through a series of amplifying levers. The diaphragm may be of mica, bakelite, aluminum or any material other than iron, since the diaphragm need not be paramagnetic, as in the case of the electro-magnetic type. In this manner it becomes possible to obtain better acoustic properties. The electro-mechanical type takes care of powerful and weak signals alike, since there is no delicate air gap to adjust between the pole pieces and the diaphragm, although some makes have an adjustment for regulating the clearance between the armature and the electro-magnet poles.

Finally, we come to the electro-dynamic loud-speaker, which makes use of a powerful electro-magnet with a small air gap, as well as a very small coil of fine wire attached to the diaphragm and free to move in the air gap. The little coil is connected with the radio set or amplifier. As the fluctuating current of the radio set or amplifier passes through this little coil, it sets up a magnetic field which reacts on the powerful magnetic flux surrounding the small coil, causing the latter to be strongly forced out or drawn into the powerful magnetic field. The coil is forced in or out in exact accordance with the fluctuations of the current which passes through it; and, since it is rigidly attached to the diaphragm, the latter has to follow its motion and in so doing it produces sounds. Thus the diaphragm translates the voice or music current coming from the radio set into audible signals. Due to the intense magnetic field in the air gap, the slightest current flowing through the little coil results in considerable movement of this coil and the attached diaphragm, which in turn means loud signals.

The electro-dynamic loudspeaker has several points in its favor. First of all, it is capable of great sound volume for a given input of energy. It will not blast or buzz as the result of excess current, since there are no moving parts that can come in contact with stationary members, as in the electro-magnetic type. It will take care of weak signals as well as powerful ones, without adjustment. Still, by regulating the strength of the magnetic field, it is possible to control the sound volume in a most delicate manner, without reducing the sensitiveness.

The Loudspeaker as a Musical Instrument

THE novelty of radio reception having worn off, since radio broadcast is now an everyday occurrence, the radio audience has developed quite a critical ear. Radio engineers have not been slow to realize the growing insistence on real music from radio receiving sets, and the acoustical end of radio reception has received due study from men trained in the handling of acoustic problems. This work is reflected in many of the present-day loudspeakers. Aside from the proper electrical design and construction, such loudspeakers must have horns especially designed for the electrical mechanism, the parts must be properly balanced, there must be no loose connections which might cause extraneous sounds, the materials used must have the desired resonant properties, and so on.

While even the best loudspeakers used heretofore have not as yet approached the realism of the head phones, that goal is being approached by leaps and bounds, especially since radio engineers have come to realize that the usual horn type of loudspeaker has its limitations, in that a horn that would reproduce accurately the full range of the musical scale, particularly the low notes, would be too large for ordinary use. The present trend toward more realistic loudspeakers seems to be in the direction of hornless loudspeakers on the one hand, and multi-loudspeaker units of different ranges of pitch, on the other. The former gets away from the resonant effect of the usual horn with its serious limitations as regards range of pitch, while the latter, admitting the limitations of any given horn, makes use of two or more horns, each of a certain range of pitch, the group of horns being arranged so as to operate at one time. Properly designed, the voice or music currents will automatically select that horn and diaphragm best suited for the pitch to be reproduced. Already, one radio set has made its appearance with a built-in multiple loudspeaker of this type, and no doubt more must follow.

The Hornless Loudspeaker

THE best example of the hornless loudspeaker is that developed in the laboratories of the American Telephone & Telegraph Company and the Western Electric Company. The design of this loudspeaker is such that the low notes of the 'cello, organ and piano, and the brass instruments of the lower register, are faithfully reproduced. This gives to the reproduction of instrumental music true depth and richness, thus making it satisfy the most exacting musical ear. While particular stress has been laid on the reproduction of the low notes, because this is the more difficult, this hornless loudspeaker reproduces the high notes of the scale with great fidelity.

The new hornless loudspeaker, which is shown in the accompanying illustrations, projects the sound waves in all directions, and individuals may sit at the sides of the instrument and hear almost as well as those sitting directly in front or at the rear of it. The sound projector of this novel loudspeaker consists of two cones of specially selected material, having their bases cemented together. The apex of one cone is connected by a driving rod to an electro-magnetic unit that responds to current impulses from the radio receiving set and thereby causes the cones to vibrate and reproduce the sound that is being sent out from the radio broadcasting studio. The cones are approximately eighteen inches in diameter, and the distance between the apex of the front cone and the grating at the back is about five inches. The whole assembly stands approximately twenty-one inches high and weighs seven pounds. No additional batteries are required to operate this loud-speaking device, since it operates on the usual two-stage audio-frequency amplifier.

It is interesting to note how this cone type loudspeaker can be mounted. The author has seen models arranged in wicker mountings intended for holding them on the ceiling of a room, quite inconspicuous and out of the way. It is understood that this type will also be available in the form of a lamp shade.

Whether a loud-speaker is of the horn or the hornless type, the truth of the matter is that the horn is becoming obsolete. Just as the phonograph horn disappeared into more and more attractive cabinets, together with the "works" of the phonograph, so must the radio loudspeaker horn disappear, either in an attractive cabinet of its own, or into the cabinet of the radio receiving set, or even into a ceiling fixture or lamp shade.

Radio Vacuum Tubes that You Can Take Apart

By Frederic M. Delano

Paris Correspondent of the SCIENTIFIC AMERICAN

In this photograph Professor Holweck points out the different units of his power tube, a tube in which the vacuum is continually renewed

ONE of the most annoying things about radio is the fact that vacuum tubes will not last forever and cannot be easily repaired. One touch of the wrong wire to your binding post and all the tubes are gone in an instant. After a certain number of hours of life the tube is likely to go out even if the wires are kept where they belong and no accident happens. And tubes are not to be bought for a few cents, nor are they likely ever to be. The precision that must go into their construction is such that it precludes the cheap prices that we have come to enjoy for such articles as the tungsten-filament electric lamps.

And the most fragile part of this expensive and delicate vacuum tube that we all must use in our radio sets is the filament. A tiny bit of tungsten wire, costing only a fraction of a cent, so small that you can scarcely see it inside the vacuum tube, repairable in a moment if you could get it out; this is the thing that breaks or burns out and destroys at least nine out of ten tubes.

What wonder, then, that a multitude of radio inventors have been busy trying to devise some way of repairing burnt-out filaments and making the tube fit once more for use.

It has remained for a famous French scientist, Professor Fernand Holweck, to devise a system by which the tube can be taken apart at any time for repairs or for inspection of its parts. The first of these demountable tubes were built nearly two years ago as a power tube supplying the transmitting wave for the great Government radio station at the Eiffel Tower, in Paris. Since that time Professor Holweck has continued his experiments on these tubes. Tubes both of larger and of smaller size have been built; the method of pumping out the gas from the tubes so as to maintain a constant vacuum has been perfected; similar tubes, firmly sealed in glass but with demountable internal parts, have been devised and put to use.

As yet the Holweck methods have not been applied to tubes as small as those used in ordinary radio reception. The way now used to maintain the vacuum in the larger power tubes is scarcely suitable, as we shall see, for use on the home-operated radio receiver.

But the successes of Professor Holweck with the larger tubes and especially his construction of a glass-contained tube the parts of which are easily demountable, may be regarded, I believe, as the first step toward the devising of a smaller tube so constructed that a filament fault can be repaired, when necessary.

The most radical departure of the Holweck power tubes from the designs that are usual for high-power vacuum tubes is the fact that the tube is attached permanently to its own vacuum pump. The vacuum in the tube is not created once for all and then left alone, as it is in ordinary tubes. It is continually renewed by the pump.

How this is done is apparent from the unit of tube and pump with which Professor Holweck is working in the photograph reproduced on this page. The vacuum tube proper is the vertical metal cylinder the top of which is touched by the finger of Professor Holweck's right hand. In the Professor's left hand is the internal framework that carries the grid and the filament, shown removed from the tube, just as it is taken out when it is necessary to repair it. The vacuum pump is the round, barrel-like device below the tube itself and to which the lower end of the tube is attached.

The filament of the tube is a tungsten wire, as usual. The grid, too, has about the character usual in power tubes. The plate, however, is a metal cylinder surrounding both the grid and the filament. Between this cylindrical plate and another metal cylinder outside it is a space filled with running water. This keeps the plate cool during the operation of the tube.

At the top end of the metal tube that constitutes the plate there fits a cap, screwed on with a thread, and which carries the leads for the electric circuits. At the bottom of the tube there is a ground joint that communicates with the vacuum pump. Both joints that open into the inner vacuum chamber of the tube, as well as the joints of the water-chamber between the plate and the outer metal cylinder, are sealed with rubber gaskets, the material of these gaskets being especially chosen so that it will not discharge any gas —or not any more gas than necessary—into the vacuum chamber which it serves to seal off from the air. Ordinary rubber gives off a great deal of gas when put in a vacuum and cannot be used.

The vacuum pump works on the rotary principle, already much used in physical laboratories to obtain a high degree of vacuum. Inside the horizontal barrel shown in the photograph there is a metal cylinder, mounted on bearings so that it can be revolved rapidly by means of the motor the electric terminals of which are seen at the right-hand end of the pump in the photograph. When this cylinder is revolved it drags along with it a film of the air next to its surface.

Between the outer surface of the revolving cylinder in the pump and the cylindrical metal shell that surrounds it and inside which it revolves, there is only a very narrow space. The revolution of the inner cylinder drags along the air inside this narrow space, so that the air is pulled over from one side of the pump to the other. On the side toward which the air is pulled there is an escape hole for the air. On the other side—the side *from* which the air is pulled—there is the hole that connects the pump with the tube that is to be exhausted.

This revolving pump is kept running whenever the vacuum tube is in use. It not only permits a tube construction that can stand a few leaks and that may be built, therefore, in such a way that it is demountable; it has another advantage. It permits the close *regulation* of the vacuum in the tube.

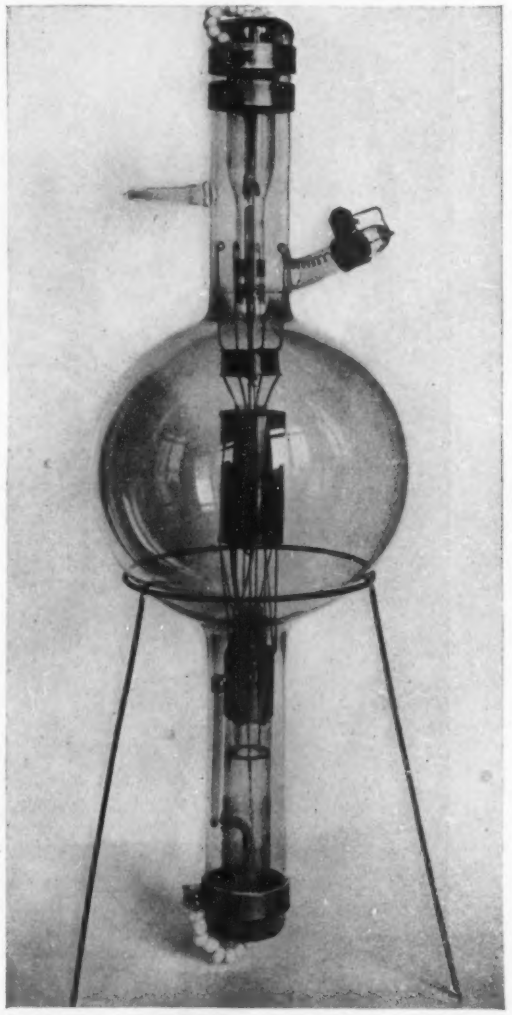
A great advantage of the Holweck tube is that its hardness or softness can be controlled. It can even be altered while the tube is running. The perfection of the vacuum in the tube depends on the speed of the pump that is keeping the tube exhausted. If for any reason the operator desires that his tube be a little softer all that he has to do is to slow up the pump. This lowers the degree of vacuum in the tube by allowing a little more gas to remain in it. Conversely, if a higher vacuum is required, corresponding to a harder tube, the operator merely increases the speed of the pump.

Tubes built on this system have been constructed to deliver as much as 80 kilowatts of power and to run with plate voltages as high as 8,000 volts. The largest tubes so far built on this model had a cylindrical plate about two and one-half inches in diameter and about eight inches long.

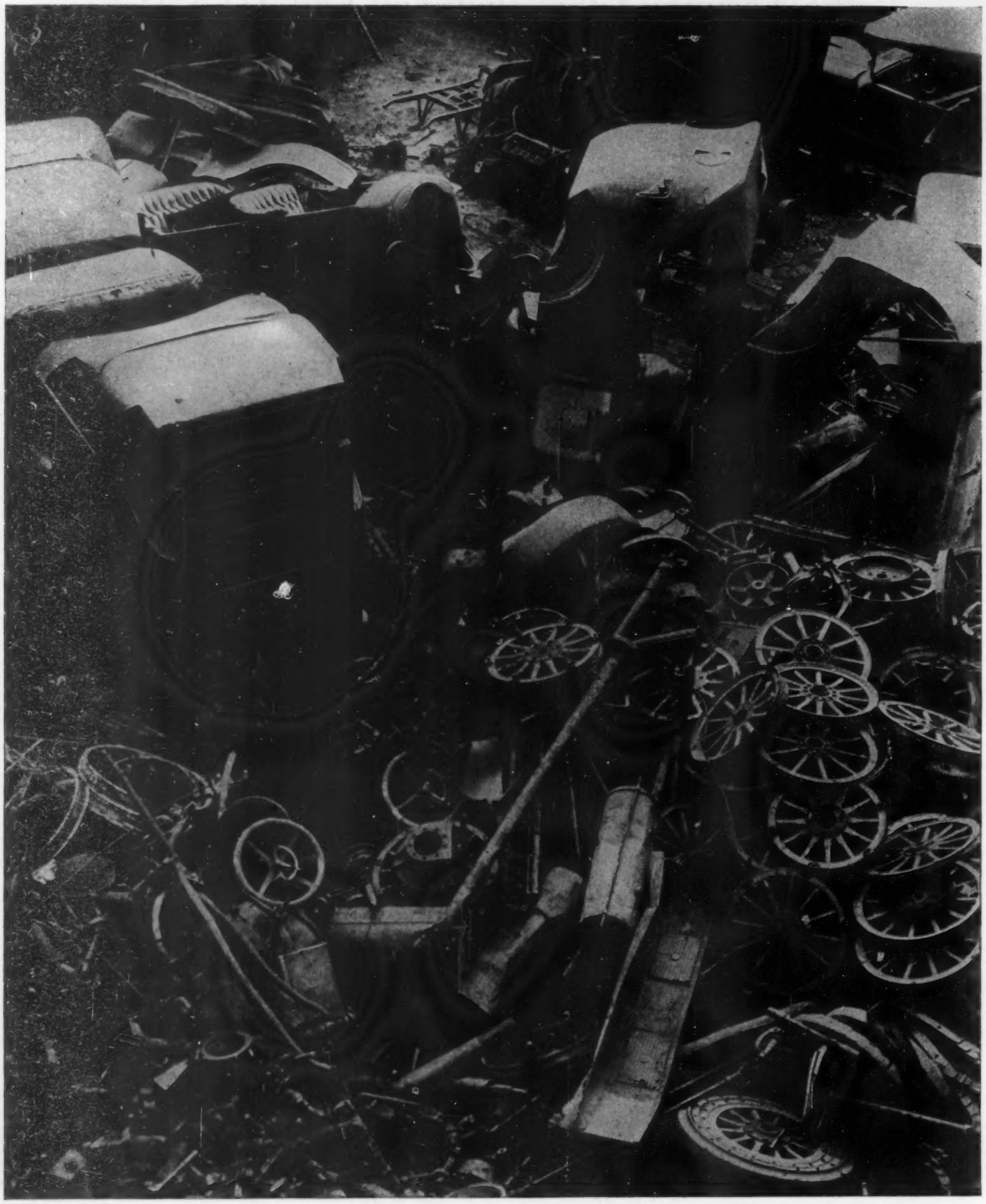
This same principle has proved useful, also, in constructing vacuum tubes for X-ray work. The modern form of X-ray tube used by surgeons and dentists depends, just as does the radio vacuum tube, on a stream of particles of electricity, the electrons, set free from a hot tungsten filament contained in a vacuum. Just as in the case of the radio tubes, it makes a difference whether an X-ray tube is hard or soft. The hard tubes give the short-wave X rays of great penetrating power; the soft tubes give waves of longer wavelength which penetrate the bodily tissues much less deeply.

The glass-contained vacuum tube also invented by Professor Holweck and illustrated on this page is not attached to a continuously-operated vacuum pump. It is exhausted like other tubes, once for all. Its interior metal parts are so constructed, however, that in case of any failure of the tube they do not have to be thrown away. The glass bulb of the tube can be cut, the metal parts removed and repaired and the tube pumped out again so that it is as good as new. In a recent address before the *Academie des Science*, in Paris, Professor Holweck stated that the cost of this repair on a 100-kilowatt power tube was only about five dollars, as against a cost of between fifty and sixty dollars for tubes constructed in the usual manner.

The extension of these important ideas of Professor Holweck to the smaller varieties of vacuum tubes used by the broadcast listener will come, it is probable, in the direction of this glass-contained tube that is evacuated once for all, rather than from the metal tubes maintained at the proper vacuum by the attachment of each one of them to its own revolving vacuum pump. The latter plan would be too cumbersome as well as too expensive for ordinary use.



In this glass-contained vacuum tube the glass bulb of the tube can be cut, the metal parts removed and repaired and the tube can be pumped out again so that it is as good as new



A Costly Dump Heap

The auto junkyard pictured above and located in Chicago is only a small corner of the country's huge and costly motor dump. Figures made public by the Commerce Commission show that out of the 4,000,000 automobiles built each year in the United States, cars to the value of the appalling sum of $2,000,000,000 are junked each year

The Latest Developments in Bank Burglary

New Scientific Devices Used by Burglars and How the Bankers Meet Them

By Edward H. Smith

IN THE year 1915 a strange thing happened in a little bank in Louisiana. On a Monday morning when the banker came down to open his doors and count his cash he found that some one had literally burned a hole in his safe, opened the locks and made off with the contents.

The banker was appalled. The shock would not have been so great had he found the thing blown open with explosives or even drilled open. But burned! Incomprehensible.

That neat little hole in the door of the safe of this small-town bank was a most significant and menacing phenomenon. It was, so far as I have been able to make out, the imprint of the first successful attack on any bank in the United States with the oxyacetylene torch.

This crime was not without its adumbrations. As early as 1908 or 1909 there appeared in Kansas City one J. G. Donaldson, who was equipped with an acetylene torch, in those days a new and somewhat fabulous instrument. Mr. Donaldson announced his belief that his fiery little tool would eat its way through burglar-proof safes with little difficulty and much despatch. A demonstration was duly staged in which the torch somehow failed to accomplish its disastrous purpose, greatly to the relief of safe makers and bankers. I mention Mr. Donaldson and his early disappointment because they have an important bearing on later and larger events.

Thus, before the event in Louisiana, there was a general feeling that banks and their funds stood in no special peril from the new tool. But after 1915 and its sudden development, there was an alarmed change of front. The bureau of the American Bankers' Association which deals with criminal attacks on banks forthwith issued a warning to its members and, what was more to the point, other burglarious applications of the torch followed.

On November 30, of the same year, an unsuccessful attack was made on the vault of the First National Bank at Osborne, Ohio, where the failure was due to an alarm which frightened the burglars away. In January of the following year, in the People's Bank at Petaskala, in the same State, the burglars had better luck, making off with about $2500. And so the torch menace to banks became a reality.

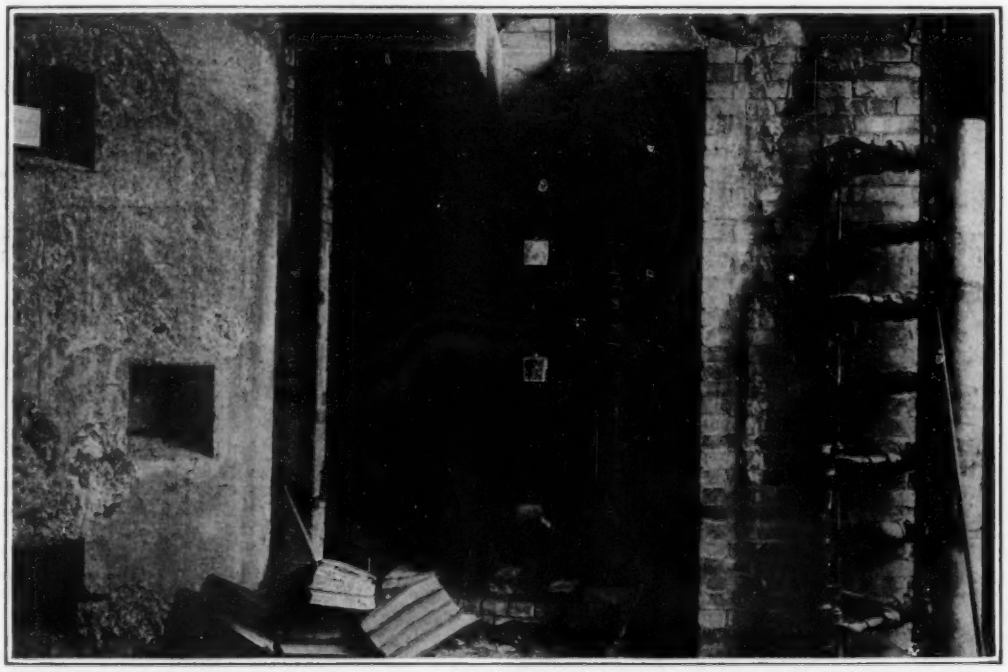
There was a general disposition to treat the new danger lightly and to minimize its possibilities. After all, the institutions attacked were small, their equipment was either antiquated or not of the best. Nor was this point of view without its temporary justification. The use of the torch by burglars did, in fact, develop slowly. It was all of five years before they succeeded against what could be termed a genuinely modern safe.

A vault burglary in Kansas City in 1922, in which the burglars used an acetylene torch to cut a manhole from the bottom of the door. The picture shows the torch and gas tanks which were left behind

Looking back on the situation, it seems strange that more vision did not enter into the calculation of bankers. They might have resurveyed the beginnings of burglary with nitroglycerine in the United States, in which case they must have seen that here, too, the development was slow and the spread of the explosive to the hands of criminals a gradual one. It might have been foreseen that the possibilities of the torch had not been exhausted and that knowledge of its powers and its improved application would find its way to the criminal world tardily. But all this is so much spilt milk.

In November, 1920, a gang of burglars using an oxyacetylene torch managed to breach a modern manganese steel safe in the Farmers' State Bank at Shipshewana, Indiana. The banking fraternity and a good many conservative safe makers woke up in the next few days and began rubbing their eyes with agitated fingers. It was true, then. The pessimists had been right. The best kind of safe was no more invulnerable than its older relatives.

In the immediate following months other heavy manganese safes were burned open in Indiana, California, Oregon and then in many other States. The crisis had come.



The furnace at the Bureau of Standards in which safes are tested before receiving the government guarantee. They are dropped while hot from a height of forty to fifty feet. This process is then repeated before the safe is opened and the contents examined

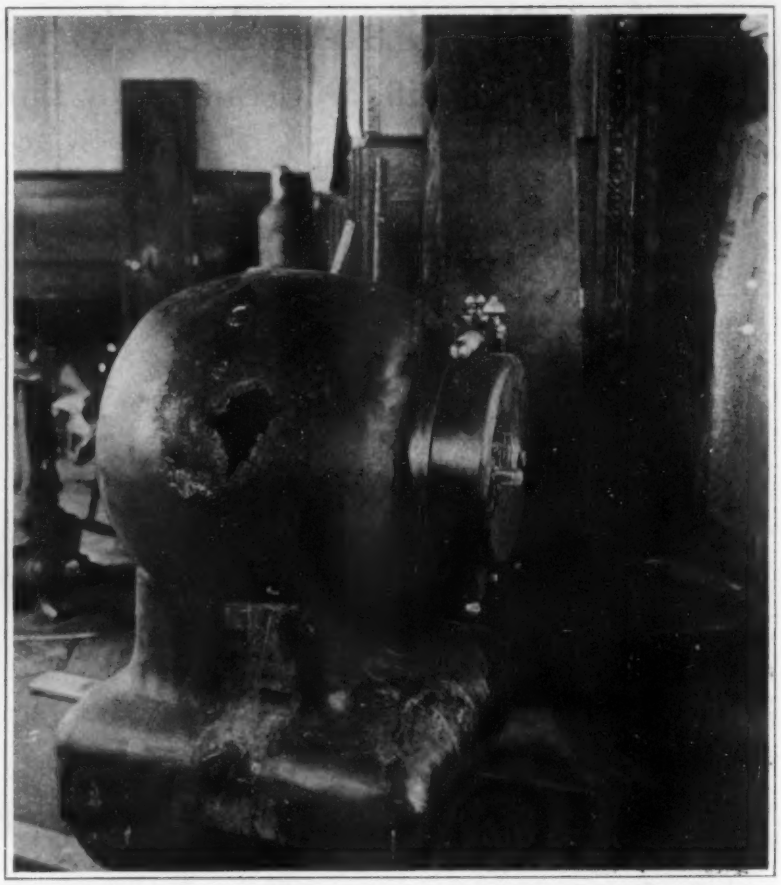
It is this crisis which at present confronts the bankers and safe manufacturers of the country. When I last wrote about bank burglars in these pages, two years ago, I called attention to the torch and to its later complement, the fluxing rod, and dwelt upon the extent to which these instruments had entered into the calculations of the builders of bank vaults, such as those used by the Federal Government. Since that time, however, there have been distinct and highly important developments, both offensive and defensive. Before we can understand the significance of these developments, however, or get the fullness of their romantic flavor it is necessary to go back a bit into the history of safe making.

Since some time before the Civil War the American safe-maker has had two problems to deal with—the attacks of burglars who used the drill and those who used explosives. In the beginning these two destructive forces were in the same hands, since the method was to drill a hole into a safe by means of which it could be mined with black powder. Later, when nitroglycerine came into use, the drill became obsolescent but its potency could still not be disregarded by the safe-maker. His product had to be proof against all the known implements of attack.

To produce such safes was more easily said than done, for the two enemy forces required for their defeat a metal possessing the antagonistic and incongruous qualities of ductility and hardness. It was easy enough to make a metal hard enough to turn the drill but such metals were brittle and flew into shards before explosives. It was, likewise, not impossible to produce metals of sufficient ductility to offer a high resistance to explosives, but such metals were soft and the drill cut through them without much trouble.

One of the first types of burglar-proof safes consisted of several sheets of iron with steel springs, intended to turn the drills, placed between the sheetings. Their makers did not realize that it was an easy matter to drill through the outer sheet, fill the interstice with

A test attack on a new resistant metal with the acetylene torch and the fluxing rod. The man who handles the rod must wear a mask, an asbestos coat and asbestos gauntlets



A round door safe made of manganese steel. This metal embodies the long-sought combination of ductility and hardness. It was drill-proof but, as our illustration shows, it was not proof against the acetylene torch

powder and so blow off the first defense, giving immediate access to the second.

Next, came the much talked of five-ply steel, sometimes called chrome steel from the fact that the hard layers contained a small percentage of chromium. Five-ply steel is a name which describes the product, three layers of soft metal to give ductility and the two layers of hard metal to give hardness, laminated together. Nitroglycerine was readily used to blow these laminations apart.

Then came Franklynite or spiegeleisen, which was simply cast iron containing about 20 percent of manganese. This substance was used for making solid cast safes. It was drill proof but brittle and so its success was limited.

Back in the days of the powder burglar there was one other theory of defense used by the safe-maker, namely the plan of an outer shell or safe with an inner strong-box or burglar-proof chest. All these safes and chests were of laminated construction except a few cast-iron specimens, and were most happy and profitable arrangements for the nitroglycerine burglar.

As a result of nitroglycerine and its ravages, Corliss, the inventor of the steam engine which bears his name, made a series of experiments and evolved a very heavy type of safe of solid chilled cast iron with walls from six to twelve inches thick. He also invented the first liquid-tight door, a globular affair, which may still be seen in use here and there.

Nitroglycerine also forced other safe makers to trim their sails to the new wind. Indeed, it changed the whole structure of safes, and the round or screw door came into being, its design having been dictated by the fact that the "soup" burglar found it easy to let his nitro seep into the cracks of the old square-door safes, which could not be made to fit tightly enough to foil the burglars.

Then, however, came a metallurgical triumph which turned the accent of safe-makers quite away from structure and back to materials. Sir Robert Hadfield of Sheffield brought forward his manganese steel, a very different substance from the earlier spiegeleisen, which also contained manganese. Hadfield's metal was a steel alloyed with from 11 to 13 percent of manganese, the mass being heated to a temperature of from 1775 to 1850 degrees Fahrenheit and then plunged. This new manganese steel embodied in itself the long sought ideal combination of ductility and hardness. If cast in sufficient volume, it could not be breached with any usable amounts of explosive and it was drill proof to the limit of testing.

In America, three men brought this new metal into use for bank safes and introduced it to the country—Lieutenant Samuel Rodman, U. S. N., Sumner A. Ely and Henry D. Hibbard. These three men formed a firm and made the first manganese steel safes. They also fought a long and costly battle with the older safe makers and their screw-door laminated safes, in which the latter lost. In time all manufacturers had to come around to solid cast construction, which meant Hadfield's manganese steel.

This metal was used mainly for safe making but it was also being applied to vaults until about 1914, when the military demand for ferromanganese became so great and the prices went so high that it had to be temporarily abandoned as a safe and vault material.

When Is a Safe Not Safe?

THE contest between the safe-cracker and the safe-maker is fast resolving itself into the old problem of the irresistible force and the immovable body—with the odds in favor of the safe-cracker.

Since the beginning of safe-making the inventors have had two sets of men to deal with—the burglars who use the drill and those who use explosives. Each new improvement of safes has been met, on the part of the burglar, with methods for successfully attacking it.

I need hardly recount what triumphs were felt when manganese steel was introduced and a solid cast safe was finally to be had that could be neither blown nor drilled. The end of the bank burglar was once more predicted and not without some justification.

But, while the makers of manganese safes were exulting in their victory and busily installing their excellent product in banks all about the land, there came to these shores a Frenchman named Fouche, perhaps, by some sweet irony, a relative of Napoleon's iron chief of police of the same name. This modern Fouche wanted nothing of us but a patent on a welding torch which was based on the idea of burning acetylene in an atmosphere of oxygen.

Here we mark the beginning of a new and terrible foe to our cash boxes.

Two years later a Scandinavian named Jotram took out patents on a process for cutting steel by means of oxygen. His plan was to heat the metal to be cut to the point of redness with Fouche's torch and then to throw against this hot spot a jet of oxygen. This is, of course, the cutter-burner torch which has been used with deadly effect.

When safe-makers began to see what this slowly perfected new tool would do in industrial use and, when their efforts were quickened by the first attacks on safes, they moved out as rapidly as they could in the direction of resistant substances. Various things were suggested and tried—high carbon steel or cast iron, cast iron with an infusion of from 20 to 25 percent of copper, copper sheets from four to six inches thick in the doors of heavy vaults, and finally, various interlarded metals, usually a cast-iron matrix with some hard refractory substance in the center. The only one of these which reached any broad employment is of cast iron with a core of large sized crystals of the electric furnace carbides of silicon, alundum or aloxite.

In 1917, the late Francis J. Napolitan, a research engineer, invented the use of the fluxing rod, a thin bar of soft iron which is placed against the metal to be burned at the point where the torch flame strikes it, acting both as a fuel for the flame and as a scouring substance which can be made to bore into the heated and softened metal of the attacked surface. The experiments made on behalf of the government in November, 1919, with the torch and fluxing rod opened the eyes of engineers to the power of this new invention and the peril in which all existing vault and safe constructions stood. Since then still more violent and terrifying methods of attack have been devised, once more, not by the burglar but by the engineers applying their talents to industrial problems.

First of all, the oxyacetylene torch itself has been developed to much greater power and size than ever before. The giant welding torches now used industrially are capable of throwing big flames and getting up a heat against a resistant metal surface far

beyond anything that could have been foreseen a few years ago.

Second comes the pipe torch. This instrument is the invention of Mr. J. A. Mohr, head of the research department of the Carnegie Steel Company, who devised it to melt out the tapholes of "frozen" steel furnaces. It consists of a number of tanks of oxygen hitched to a long one-half or three-quarters-inch iron pipe. This pipe is heated to redness at the end. Then the stream of oxygen is allowed to flow through it. The red hot iron ignites the oxygen, which in turn burns up the iron pipe as fuel, generating a tremendous amount of heat, theoretically placed at 6640 degrees Fahrenheit.

Third, we must consider the so-called dog-house attack, an improvement on and development from the pipe torch. It was found by experimenters that in the use of the pipe torch against the smooth surfaces of high-resistance metals, such as are encountered in attacking a modern vault, a good deal of the heat was diffused and much of the iron fuel permitted to run off and be lost as it melted. Accordingly, the dog-house was improvised. It is no more than a box of graphite, measuring about eight by eight inches and six inches deep, with one surface open. It is fixed to the front or side of a vault or block of metal with wet fire clay or some other material along its free edges, thus making an enclosure. There is a hole in its facing surface through which the red-hot end of the pipe torch is introduced into the dog-house, a vent at the top for escaping gases and a small hole at the bottom through which excess accumulations of molten metal may flow off. Inside this chest of graphite the accumulated molten iron from the burning pipe and the oxygen flame unite in a frightful combustion, whose heat is confined to the spot of attack by the dog-house, thus minimizing the heat wastage.

Finally, the fourth new method of attack is to be found in what is called the regenerative torch. This onslaught is considered so deadly that I am cautioned against describing it beyond saying that it is capable of temperatures and destructive actions beyond those of any other torch.

So far as is known, none of these four recently devised tools has been used by a burglar. It must, however, be stated that there is nothing specially complicated about any of them and no reason why a burglar cannot employ one or all under favorable circumstances. How long it will be before such employment may be made is a question for the future.

What concerns us immediately is the possibility of devising a metal or other substance capable of resisting such violent and devastating onslaughts. It may be said that no safe now in use can hope to stand up before the more effective of these tools for more than a relatively few minutes. Indeed, they tear their fiery way through metal defences once considered impregnable in seconds rather than minutes.

There was a time when I was disposed to reason that no metal or combination of metals could hope to defy the power of the torches, for the reason that all metals or alloys had to be fused before they could be formed into safes, vaults or plates, and what could be fused once could naturally be fused again. A glance at the fusion points of various metals and other substances, compared with the heat of the oxyacetylene flame will seem to support this view. Cast iron, for instance, melts at 2200 to 2400 Fahrenheit, steel at 2400 to 2600, manganese steel at 2600 to 2700, wrought iron at 3200 to 3300 and the best kind of fire bricks at 3700 to 3900. Carborundum sublimates at somewhere between 4200 and 4300, zinconium silicate at 4300 to 4350, the oxide between 4900 and 5000. Uranium fuses at about 4350 degrees, osmium at 4980, tungsten at 6020 and even carbon at 6500. These latter are approximate figures. On the other hand, the oxyacetylene flame has a theoretical temperature of 7878 degrees.

On the surface, it would seem that nothing could stand before such a torturing flame. But here the problem of heat waste intrudes itself. Radiation, conduction and convection carry off a great part of the heat energy of the torch flame, especially when the attempt is made to attack a great vault door or very heavy safe with a relatively small point of heating such as can be got from even a large modern torch. The mass of metal "absorbs" and wastes a great part of the heat; just how much is not known. In this fact was found the hope of devising materials which would successfully resist those tremendously high temperatures to be found in the torch flame.

Are We on the Eve of a Great Epidemic of Bank Burglaries?

RECENT defensive experiments and inventions might lead us to forecast an end to bank burglary. But to bring this about in fact is not so easy. What concerns safe-makers immediately is the possibility of devising some metal or other substance capable of resisting the devastating onslaught of the various types of the acetylene torch, a high-temperature device which will eat its fiery way through metal defences once thought absolutely impregnable.

Here Mr. Donaldson re-enters the picture. His interest in the problems raised by the torch began, as I have said, about 16 years ago. At that time he was trying to attack safes with the torch. It was not long, however, before his interest veered to the other side and he commenced his experiments with resistant materials. Several years ago Mr. Donaldson appeared at Columbia University with the fruit of his earlier struggles and began a long continued series of laboratory experiments, assisted by Dr. Ralph H. McKee and Mr. Henry L. Coles of Columbia. After some years of research he retired to his own laboratories and there finally evolved a new set of composite metals, which he was finally able to work into solid casting, having a matrix of metal offering a high resistance to the drill, the practical explosives and the torch as well. Inside this matrix is a core of somewhat more costly amalgamated metals which possess still higher resistances.

This material, in the form of plates and castings has within the present year been subjected to the most exhaustive and gruelling tests in independent laboratories, which had been selected to do the testing by interested banks, insurance companies and the like. To some of these tests and demonstrations the writer has been a witness. The others he has studied in the reports of the testing engineers—and studied with an initial skepticism.

The Donaldson metals have turned, time and again, the largest power drills and successfully resisted all attacks with commercial explosives. The largest types of welding torches have been played upon these substances in relays for hours, with the result that the torch tips finally melted and backfired without making any impression on the attacked substances. I have personally seen them attacked with the pipe torch and graphite dog-house for long enough to eat up a 20-foot length of pipe and exhaust a whole battery of oxygen tanks. Still no result. I have seen the same form of attack literally shoot holes into all the other safe metals and compositions known to me. It was after these long series of attacks and demonstrations that the Donaldson materials were employed in the newly finished vaults of the Chemical National Bank in New York.

The romantic conversion of the inventor, from a salesman who wanted to demonstrate the power of the torch, to a metallurgist and experimenter who perhaps has found the means of definitely defeating the same torch and better ones, is surely not the least interesting chapter in the long history of safe making and safe breaking.

The whole thing raises two fascinating questions: First, are we on the eve of a great epidemic of bank burglaries? Second, will this expected wave be the last and will the bank burglar then pass out of the criminal picture, as have the road agent and the green goods man?

As to the first: There are, unless memory fails, between thirty and forty thousand banks in the United States and among them few are equipped to withstand attacks such as are now possible to the burglar. Fully 95 percent of them were either outfitted with their defensive apparatus before the torch was considered important or before such things as pipe torches and dog-houses were thought of.

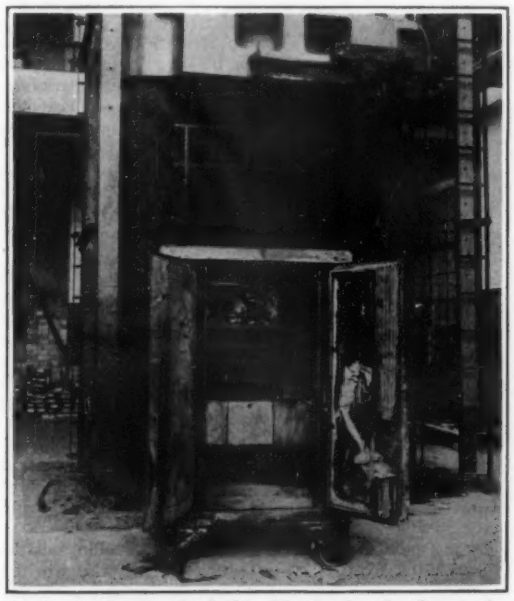
We must recognize that the torch in its present state of development is a much more powerful tool than nitroglycerine ever was, since it will open vaults and safes against which that explosive has always been useless.

And we must not forget the even more important factor of silence.

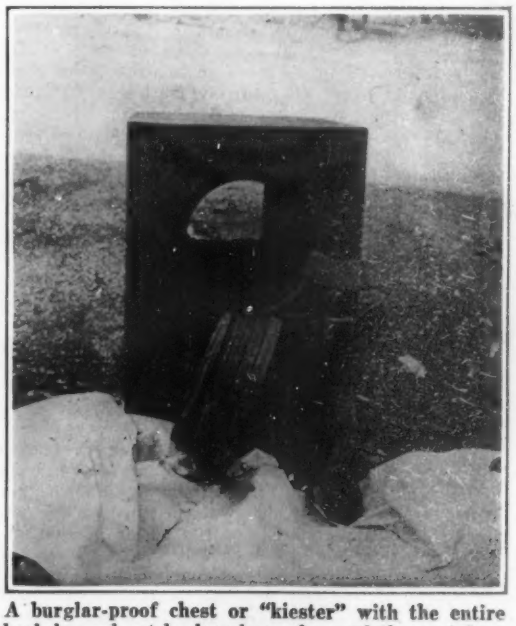
Many poorly equipped banks in both small and large towns and cities have been immune from burglarious attacks in the past because of advantageous location. That is to say, the banks were so situated with respect to other business houses, police stations, hotels and sleeping citizens that they could not be attacked with noisy explosives. All such banks become immediately vulnerable to the torch, which is as silent as a well oiled motor. It makes no more than a hiss and a shower of sparks, which may both be confined under a hood. Attacks with the pipe torch and the regenerative torch, of course, produce a veritable rain of sparks and a flow of brilliant molten metal, but even these phenomena are relatively silent and there is nothing about them to waken a sleeper in the next building or even on the floor above.

To meet this extreme peril there is nothing but the promise of new resistant materials such as those invented by Donaldson and his associates. Granting that these new metals are all they seem to be, there is still no hope that they can more than reduce the immediate danger. To install new torch-proof equipment in the thousands of exposed banks is, according to experience, a task which will require a good many years, even if the bankers all see the peril immediately and act to avert it.

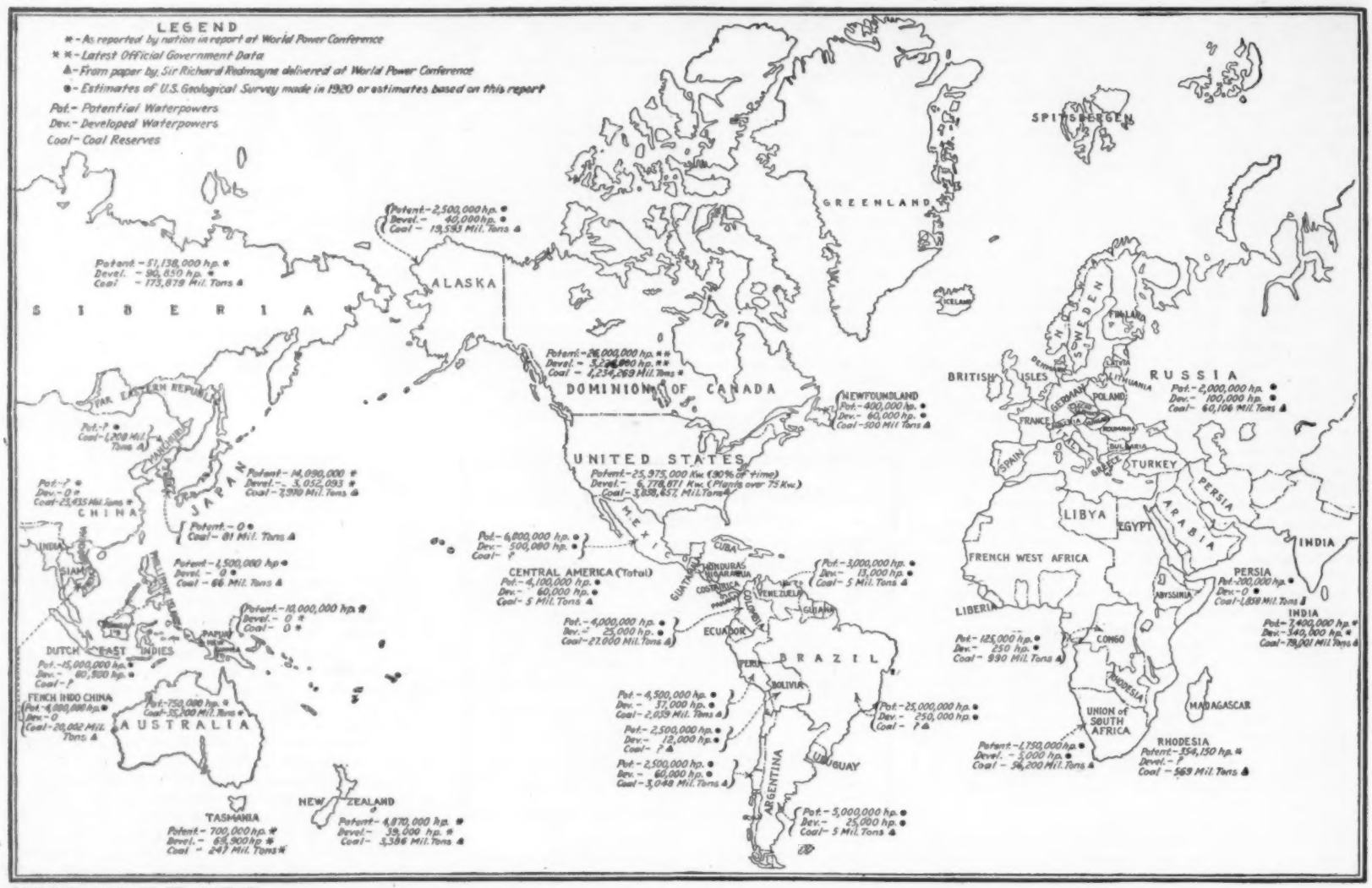
These new metals are definitely beyond the fusing power of the most powerful torches and it is reasonable to suppose that metallurgy will keep pace with any possible further improvement of these powerful melting tools. On the other hand, invention may at any time produce entirely new methods of attack employing quite unsuspected physical forces. For the present, however, it may be said that the means of foiling the known tools of bank burglary seem to be at hand.



In the background of this illustration is shown the giant press used by the United States Bureau of Standards for testing the strength of safes



A burglar-proof chest or "kiester" with the entire back burned out by burglars who used the acetylene torch described in this article



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Power resources of the world, embodying data reported at the first World Power Conference in London

Is the End of Our Power Resources In Sight?

New Facts About This Momentous Question Were Gathered at the Recent World Power Conference

POWER is the lifeblood of civilization. If by some natural cataclysm all the coal and oil and water power in the world were suddenly snatched away, the majority of people who live in civilized countries would have to die. The survivors would revert to savagery.

There is suspicion that these superlatively necessary resources of ours in coal and oil are being wasted, that their exhaustion is no more than around the corner of the next century, that our civilization is threatened, in consequence, with an early and disastrous end. There is talk of possible power from waves and winds, of the stores of power which some physicists believe may be obtainable from the atoms of matter. It is the business of science, men say, to devise new ways of getting power.

But the first business of science about power is to take stock of what resources we have. That was done during the past summer at the World Power Conference in London. Hundreds of engineers and experts from all over the world met to report the power resources of their respective countries and to confer about the problems of utilization and conservation. The conference resulted, among other things, in the most complete and accurate survey of world power resources ever made.

The more important data of this survey, together with other available data, have been embodied in useful maps, published in a recent issue of the *Electrical World* (New York), which we reproduce on this page with the kind permission of the editor of that publication.

Perhaps the feature of these maps most surprising to the layman is the fact that the total coal resources of the world come out so large and the water power resources so small. We have been taught—by the newspapers if not by the professors—to think of this the other way around. Coal, it has been said, is nearly gone. We must turn to the "white coal" of our rivers and waterfalls. It will be our salvation.

But what are the facts? The total coal of the world,

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Power resources of the various European countries

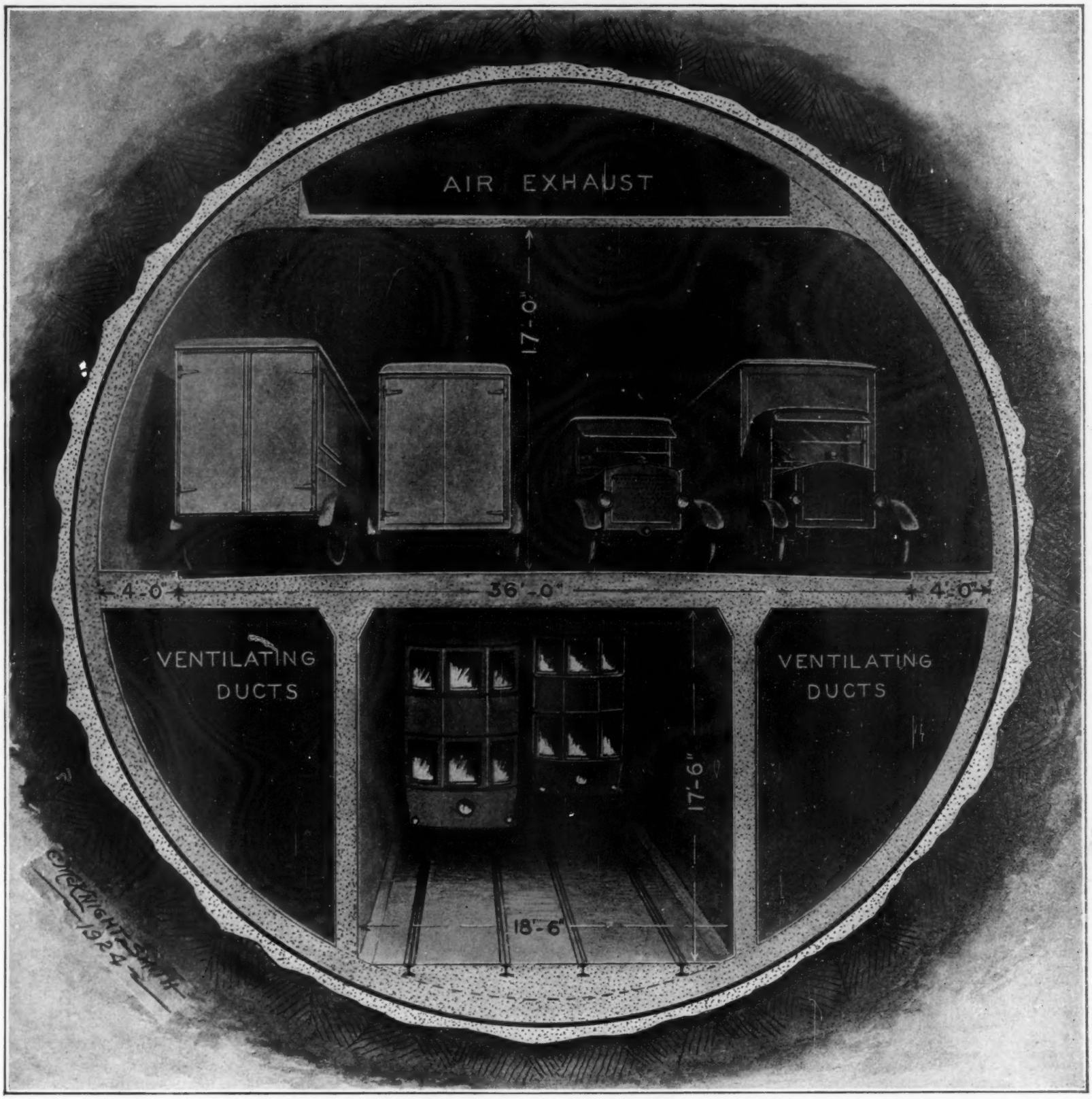
as reported to the World Power Conference, aggregates the tremendous total of 7,397,553,000,000 metric tons, a metric ton being 1,000 kilograms and approximately equal to an ordinary American ton. At the present rate of use of coal this is enough for some 4,000 years. Of course, the rate of use is increasing and it is true, also, that some forty percent of the total coal reserve is of lower than bituminous grade. But these considerations are offset by the fact that the figure given includes only the *known* reserves of coal whereas, all geologists agree that many coal beds are still undiscovered, especially in the countries, like China and Africa, that have been less completely explored.

Turning to water power, the total potential water power for the whole world, according to the maps of the *Electrical World* equals only some 293,000,000 horsepower, about one-tenth of which is now developed and more or less in use.

It is difficult to make any accurate estimate of the present use of power in the world, but rough figures (our own, not from the *Electrical World*) indicate that if all the power and heat in the world were supplied from water power instead of largely from coal and oil, as now, we would then have to have a total water power development of at least 200,000,000 horsepower and possibly as much as 250,000,000 horsepower.

This means that water power can never supply the power needs of the world. Even for our present use of power (and heat) we would need nearly as much water power as is available, the recent surveys indicate, in the entire world.

Some countries are in a more favorable position. The United States and Canada lead all the world in the water power resources that they possess. This is due, of course, to the existence of great mountain ranges, providing the necessary fall for streams, and to an ample rainfall, which provides these streams.



This Great Tunnel, Forty-four Feet in Diameter, Will be the Largest in Existence

THE above sectional drawing represents the great tunnel which is about to be built under the Mersey, linking the City of Liverpool with Birkenhead and the adjacent towns on the south bank of the river. It will have an internal diameter of forty-four feet, or more than the Hudson River tunnel now under construction. It will be built of cast iron with a lining of concrete, the space between the cast iron and the sandstone rock being filled with a mixture of cement and lime forced in under pressure.

The main roadway on the upper deck is thirty-six feet wide, and will accommodate two lines of traffic going in either direction. On each side of this roadway is a four-foot footpath for the use of the operating staff. On the lower deck is a double row of tracks for street cars.

The narrowest part of the river, where the tunnel is to be built, varies in breadth from 3,000 to 3,600 feet, but the approaches on each side will be the greater part of a mile in length, so that the length from portal to portal will be about 7,000 feet. With a view of curtailing the length to a minimum, the gradients for the heavy traffic will be one in thirty and for the light traffic one in twenty, even stiffer gradients being employed for the street-car lines.

Both ends of the tunnel will have two branch tunnels. On the Liverpool side one branch for light traffic and street cars, will be forty-four feet in diameter and the other for the heavy dock traffic is to be reduced to a diameter of twenty-seven and one-half feet.

The tunnel will be lighted throughout, and ample ventilation will be secured by pumping fresh air through the conduit below the lower deck of the tunnel on either side of the street-car section.

The air is to be introduced into the vehicular sections of the tunnel through ducts conveniently spaced, thereby avoiding a longitudinal rush of air of a high velocity. The vitiated atmosphere will be drawn out in a like manner through ducts leading into the upper conduit.

The estimated cost of the tunnel is $132,200,000, or $20,750,000 less than that of a bridge, the plans for which were rejected. Apart from the excessive cost, a bridge possesses several drawbacks not met with in a tunnel. Among these drawbacks is the great headroom required to allow the present-day mammoth liners to pass underneath. This great height would have involved longer or steeper gradients, in which respect the approaches would have had to be a mile in length on either side. Exposure to the weather and the obstruction to navigation were other objectionable features.

The Story of Steel—XI

The Manufacture of Butt-Welded and Lap-Welded Steel Pipe

AMONG the commodities which man has fabricated for his own use but few have a more ancient history than that of tubing, or pipe, which from time immemorial has been made in a more or less crude form of such materials as the slow progress of the arts has made available. The stone aqueduct, that most ancient device for the conveyance of water through a closed conduit, might almost be said to head the list in point of antiquity—at least, when it was built in smaller sizes. The ancients, we know, formed pipe out of various metals—copper, bronze, etc., and those great engineers the Romans made elaborate use of lead piping. It was inevitable that, with the development of iron manufacture this excellent material should be used increasingly for pipe. In the early days of this Republic, when iron works were few and widely scattered, we know that trees were cut down, bored and wedged together to distribute the water supply of the more important towns of that period; and, even today, the old wooden pipes are being dug up as we sink foundations for our modern buildings.

The introduction of artificial gas for lighting purposes, the demand for reliable tubes for steam boilers, to say nothing of the call for pipe of lasting quality for the large municipal water systems—all these conditions led naturally to the endeavor to produce pipe from wrought iron, and we are told that the first furnace for making butt-welded pipe in this country was made about 1832 in the cellar of a shop at Third and Walnut Streets, Philadelphia. From that small beginning there has grown up the present huge industry, whose total output in the United States of all kinds of tubing and piping reached in 1923 a total of 3,351,023 tons, the largest in the history of this particular branch of the steel industry.

Up to the period of the early eighties of the Nineteenth Century, outside of such special piping as was made of brass and copper, tubular products were made entirely from wrought iron; for it was believed that steel did not offer the suitable welding and other qualities for first-class pipe. During the eighties, however, there was considerable experimental effort directed toward the utilization of steel for the manufacture of welded pipe and boiler tubes, although these early efforts were met by the prejudices and opposition which seem to be inevitable when any radical change is introduced in a long-established industry. In proof of this we quote from a paper read before the Engineers' Society of Western Pennsylvania on June 17, 1888, by Mr. Thomas J. Bray of the National Tube Company: "Toward the latter part of August about 30 tons of steel were made and rolled into skelp, and delivered at the tube works as a trial lot, to be made up into pipe. . . . The welders at the furnace said at the outset that it would not do; that it would not stand firm; and by reason of their prejudice against steel they subjected it to abuse by severe overheating; yet strange to say, every piece of that lot made a sound, salable pipe, the welders remarking that it was the best material to weld they had ever handled."

In the course of time, tubing came to be made out of Bessemer steel, and in later years open-hearth steel came to be utilized for the best grades of pipe. The brilliant success attending the use of steel in pipe manufacture is proved by the fact that, whereas in 1890 probably less than five percent of the wrought tubular products made in this country was of steel, in less than 30 years the situation had practically reversed itself; so that today well over 90 percent of the wrought tubular products in this country are of steel.

Steel pipe is made from long strips of plate steel by curving them into circular or tubular form, and then welding the adjoining longitudinal edges by what is known either as a butt-weld or a lap-weld.

Our illustrations show the outstanding steps in this process. The manufacture of the steel for steel pipe is broadly similar in any branch of the steel-making industry, as already described in the present series of articles. The charge in the blast furnace, so far as the ore for tubular products is concerned, is made up of various ores selected and mixed so as to produce the steel required. The ingots are heated in the soaking pits and rolled down into blooms and slabs, and finally into those long, comparatively thin and narrow strips of steel plate which are known as skelp. The ingots are first elongated by rolling, and while hot are sheared to the proper length. They are then carried to the reheating furnaces at the upper end of the skelp mill, as it is called, in which the blooms are rolled down to the proper weight and thickness for the size of pipe required. In the more modern plants the rolling mills are of the continuous type, the blooms entering at one end of the mill and traveling through several sets of rolls continuously in one direction, until they emerge at the lower end as finished skelp.

Butt-Welding

The skelp for butt-welding is charged into a long furnace and raised to the welding temperature. When it has reached the proper heat, one end is grasped by a long-handled tongs, and pulled through a die or bell of the form shown in one of our engravings. The end of the bell next the furnace is in the form of a stout, flat plate, the edges of which gradually curve up to form a circular opening slightly larger than the pipe which is to be finished. After they have gripped the end of the skelp, the handles of the tongs are connected to an endless chain which travels in the middle of a draw-bench. This chain is in the form of a long continuous link which travels away from the furnace on the top of the bench, returning beneath it, and it is driven by motors of great power. The moment the tongs are linked to the chain they and the skelp are drawn forward, and as the pipe passes through the die it is formed up into a circular tube, with its two edges abutting. For some sizes of pipe the skelp is drawn through two bells at one heat, the last pass being made through a bell which is slightly smaller than the other. The width of the skelp is slightly greater than the inside circumference of the bell, so that the edges are forced to abut squarely against each other, and are pressed together into a sound weld. For pipe of extra strength the skelp is drawn successively through bells of decreasing size and is re-heated between the draws, so that the seam will be thoroughly welded.

After being welded the pipe passes through the sizing rolls where it is slightly reduced in diameter and elongated. From the sizing rolls the pipe is conveyed over a transfer table to other rolls, in which it is slightly reduced and elongated and rolled to its finished size and circular contour. Any heavy mill scale or welding scale is removed by this rolling, leaving the pipe walls smooth and clean.

The pipe leaves the last span of rolls at a high temperature, and it is cooled by passing it slowly over a table; after which it is cooled enough to pass through a set of cross-rolls, which serve to give added smoothness to the pipe surface. These cross-rolls are somewhat larger in diameter at the ends than at the center, the surface being slightly curved in a longitudinal direction. Their axes are also somewhat inclined to each other, with the result that as the pipe is drawn through the rolls, its whole surface is in contact with the rolls and receives a high finish. The butt-welded pipe is then washed to remove the loosened scale and any foreign matter, and some sizes have the loose scale blown out by a blast of compressed air. The ends of the pipe are cut off, to remove the portions that have been bruised by the jaws of the welding tongs, and the pipe is then threaded and a coupling is screwed on one end. Finally, the pipe is tested by hydraulic pressure which in butt-welded pipe varies from 700 to 800 pounds to the square inch.

Lap-Welded Pipe

Although pipe, in sizes of from 1¼ to 3 inches, inclusive, may be made either by the butt-welding or lap-welding process, practically all pipe in these smaller sizes is made by the butt-weld process, while pipe of from 3 inches up to 30 inches, if that size be required, is made by the lap-weld process, which is so named because, instead of butting the edges together, they are overlapped and welded when in this position. The difference between the two is clearly shown in the small sketch at the top of the adjoining page.

The first step in making lap-welded pipe is to bevel the edges of the pipe to form the lap. When the skelp has been heated to a suitable temperature for bending, it is pushed out of the furnace into a set of two-high scarfing rolls, which bevel the edges of the skelp in such a way that when they overlap and are welded there will be no undesirable thickness there. The scarfing rolls are formed with a beveled collar at one end, and they are so set in the housing that the bevel collar of one roll is to the left and the bevel collar of the other roll is to the right. By this arrangement the scarf, as the skelp comes from the rolls, is on the upper side at one edge of the skelp and on the lower side at the other edge; with the result that, when the skelp is bent into circular form, the two scarfs will overlap as shown in the little sketch above referred to.

The skelp is then conveyed over a roller table to the bending or draw-bench. Here the forward end of it is gripped, as in the case of butt-welding, by the jaws of a pair of heavy tongs which are themselves attached to the endless chain of the draw-bench. The skelp is now pulled forward into a bending die, which forms it into circular shape with the edges overlapping. The action of this die is similar to that used in butt-welding, as above described.

Skelp for pipe over 12 inches in diameter is formed up in a three-roll bending machine, in which two rolls are placed adjoining and the third above but between them. The partially formed tube is then rolled down an inclined transfer table and conveyed, with several others, into the welding furnace. When the tube has been heated evenly throughout to the welding temperature, it is pushed out through the back of the furnace into the welding rolls.

The welding rolls are two-high, and each is accurately turned to a semi-circular contour, so that the opening between the rolls is circular and of the correct diameter to correspond with the outside diameter of the finished pipe. Between the rolls and carried on the end of a long stout bar or rod is a ball or mandrel, which is shaped somewhat like the head of a revolver bullet. Now it will be seen that since the annular space between the mandrel and the surface of the rolls is about equal to the thickness of the pipe, when the tube, with its overlapping edges at the top, passes between the rolls, the pressure set up between the bottom surface of the top roll and the upper surface of the mandrel will press the overlapping edges of the pipe together with great force and effect a sound weld.

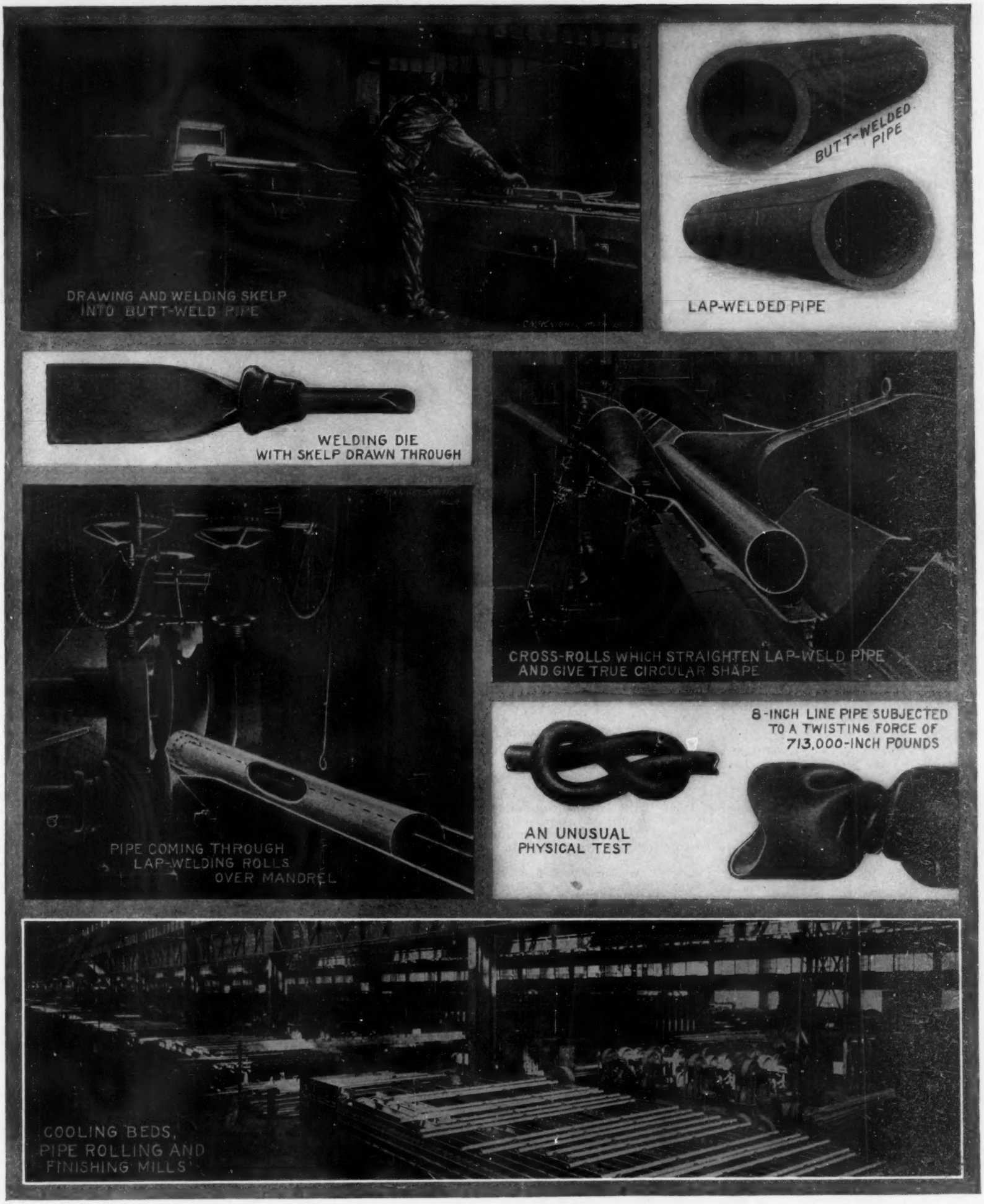
The mandrel is then removed from the pipe and the latter is rolled on to a transfer table. If the weld is not quite satisfactory, the tube is returned to the welding furnace and again passed through the welding rolls. The next step is to pass the tube, which is still white-hot, through a set of sizing rolls, which are similar in shape to the welding rolls and serve to reduce the pipe to the required external diameter. It is customary to give the tube three passes between these rolls. The tube is then carried on by live rollers into the cross-rolls, which are similar to those described in butt-welding, and here the weld is strengthened and its surface is thoroughly rounded off.

The welded pipe is now transferred slowly (so that it may have time to cool) to the cold-saw, where the irregular ends are cropped. In the larger pipes the ends are cut off in a rotary-type shear by means of three rotating disks, which cut the pipe, there being two disks at the bottom and one at the top.

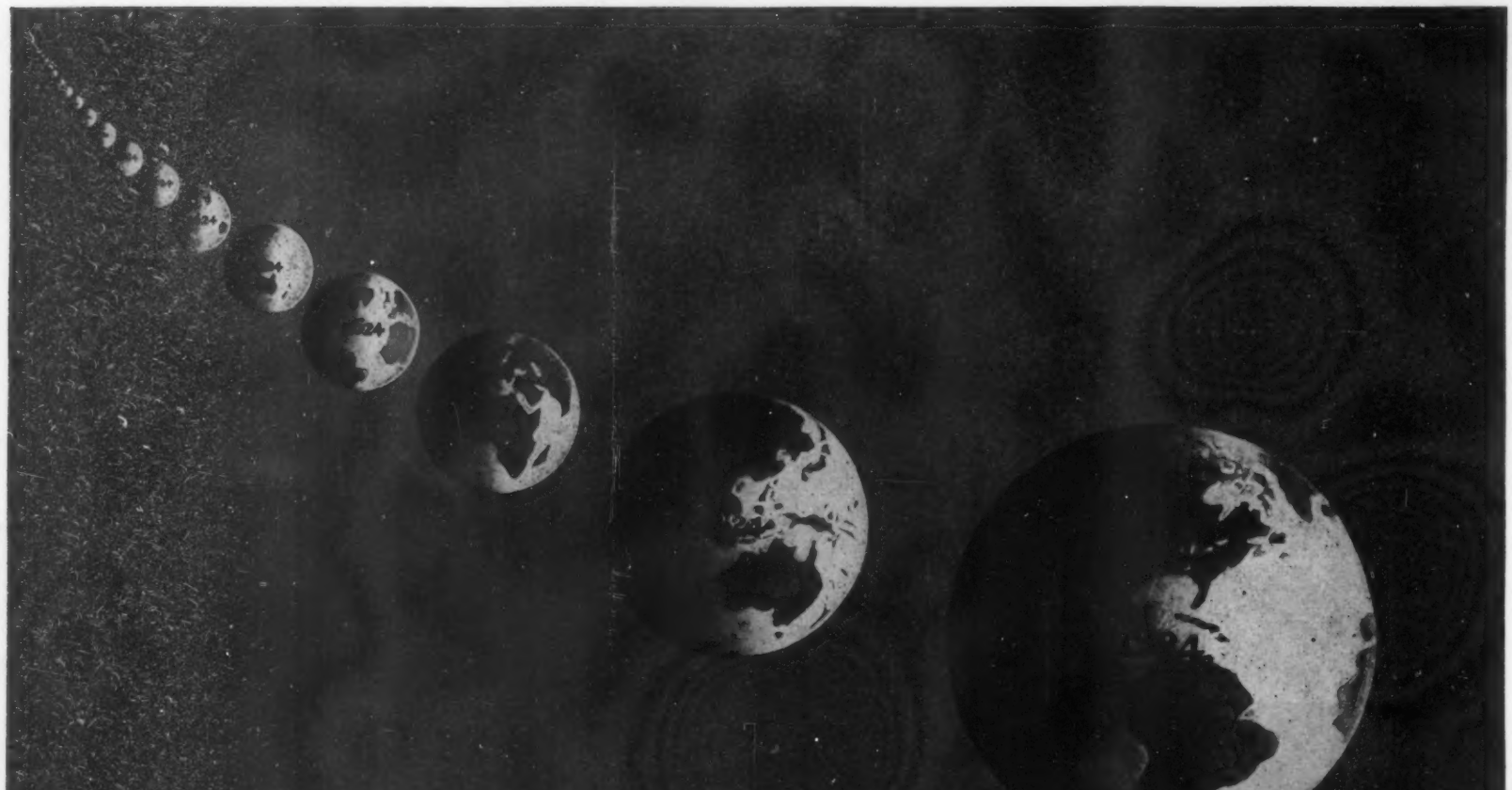
The last step is to inspect the pipe, weigh and measure it. After this is done in the case of the larger pipes, they are transferred to the threading shop. Here, after threading, a coupling or nipple is screwed on one end and the pipe is ready for delivery. It should be mentioned that the larger pipes, like the butt-welded pipes, are subjected to hydrostatic pressure, which they must stand without leaking. The pressure used in the test depends, of course, on the size of the tube and service to which it is to be put. For standard-weight pipe the test is made at from 600 to 1000 pounds per square inch, and extra strong pipe is subjected to from 700 to 2500 pounds per square inch. The pipe is then taken to the shipping department, where it is made into bundles and tagged for shipment.

Civilization and Pipe

It has been said that the standing of a country in the family of civilized nations may be measured by the amount of pipe which that country uses. The home conveniences of a modern workman are better than anything possessed by any Emperor of Rome or any King of Babylon. The main reason is cheap pipe. This article describes some of the ways in which this great modern invention is produced.


DRAWING AND WELDING SKELP INTO BUTT-WELD PIPE
BUTT-WELDED PIPE
LAP-WELDED PIPE
WELDING DIE WITH SKELP DRAWN THROUGH
CROSS-ROLLS WHICH STRAIGHTEN LAP-WELD PIPE AND GIVE TRUE CIRCULAR SHAPE
PIPE COMING THROUGH LAP-WELDING ROLLS OVER MANDREL
8-INCH LINE PIPE SUBJECTED TO A TWISTING FORCE OF 713,000-INCH POUNDS
AN UNUSUAL PHYSICAL TEST
COOLING BEDS, PIPE ROLLING AND FINISHING MILLS

How the flat strips of steel are bent and welded to form lengths of pipe. The distinction between the two standard methods of pipe welding is shown clearly in the upper right-hand corner of the drawing



Our earth is moving in time as well as in space. Stretching back into the unfathomable depths of the past we can imagine a long line of earth-images each one representing what our planet once was like. Forward into the future stretches another time path—still unforeseeable—that we will follow in the coming centuries. Can we learn to travel these time paths at will, either backward into the past or forward into the future? Is time a fourth dimension that we can move along, at will, as we move along the three dimensions of space? These are the questions that Dr. Rashevsky discusses in this article, the second of his remarkable series on The Real Nature of the World

Is Time the Fourth Dimension?

By Nicolas P. Rashevsky

Special Lecturer at New York University; formerly of the Russian University at Kieff and of the Department for Russian Students at the University and Polytechnicum at Prague

THE idea that time may be regarded as a fourth dimension quite similar to the familiar three dimensions of space is no new idea in human thinking. More than thirty years ago Mr. H. G. Wells used it as the inspiration of his remarkable novel, "The Time Machine." This imagined machine was what might have been called a time locomotive. By its aid the hero could travel off along the time dimension in either direction, back into the past or forward into the future, just as men now build airplanes by which they travel at will through the three dimensions of space.

Among the more strictly scientific sponsers of this idea the best known is the distinguished German mathematician, Dr. H. Minkowsky. As long ago as 1909 Minkowsky claimed to have "reduced time and space, considered separately, to shadows," leaving for the real framework of the spacial and temporal universe only a sort of inseparable blend of time and space, the thing that theorists have come to call "space-time," much as when we speak of "salt-water" we mean that to ordinary procedures the salted water appears as an inseparable blend of water and salt.

This idea of blended space and time has become one of the customary doctrines of the followers of Einstein in his theory of relativity. It greatly assists, as we shall see, the mathematical formulation upon which the theory of relativity so largely depends. But is it really true? Is the "space-time" blend of Minkowsky a real thing, corresponding to something in the actual universe, or is it a mere convenient mathematical fiction? And if the space-time blend is real (or if it *may be* real) can we separate out of it a single fourth dimension which corresponds to time and along which we might learn to travel, in reality, as Mr. Wells' hero did in imagination, visiting the past or the future as we now visit the accessible parts of space?

To answer these questions we must examine the origin and probable nature of our ideas of time and space.

It is apparent, first of all, that our mind thinks always in terms of the three dimensions of space. You seem to think of a two-dimension something; for example, of a diagram drawn on paper. But a little consideration will show you that you do not really think of this as being two-dimensional. You think of the diagram as being *in space* and you cannot avoid doing so. In your mental picture of a two-dimensional diagram there is always space underneath the diagram, above it, behind it, in front of it and to the right and left of it. To imagine a two-dimensional diagram, or any other two-dimensional thing, *alone*, entirely unsurrounded by space, is just as impossible as to imagine yourself turned inside out by inversion into a fourth dimension. You can imagine such things as *possible* in theory, but you cannot picture to yourself what they would be like.

We must conclude then, as has been perceived, indeed, by practically all philosophers for centuries past, that the human mind shows a preponderant—in effect, an exclusive—sympathy for thinking of things as located within a framework consisting of the usual three dimensions of space. The mind shows, also, a preponderant sympathy for thinking of the world as enmeshed in a uniformly flowing time, but that is a point to which we will return a little later.

Taking first the idea of three-dimensional space, it is natural to ask ourselves *why* the mind has this preponderant sympathy for a special kind of space when it is quite possible, as we saw in the preceding article of this series, to imagine an infinite number of kinds of space no one of which has any more (or less) assurance of being real and absolute than has any other one.

On the ground of pure logic there are two possible answers to this question. One of them is to say that the three-dimensional space which we think that we perceive has, in reality, an objective existence outside ourselves; that it constitutes in some unexplained fashion one of the properties of the real universe. This is not a very satisfactory answer. It amounts to saying no more than that "space is three-dimensional because it is three-dimensional."

The second explanation is more satisfactory. It assumes that our idea of space is not a law of the universe but is a law of our mind. In some way, says this explanation, the human mind has made for itself the customary idea of three-dimensional space. This three-dimensional idea is not necessarily correct or perfect; the mind may have grasped only one aspect of the universe. That aspect we call space. We may be like men who have lived all their lives at the foot of a mountain without ever having climbed a mountain at all. To them the mountain is like a painted scene. They have no sense of depth in it. Their idea of it is limited and incomplete.

But this explanation that space is a figment of the mind is derived, so far in our argument, from logic only. It is one of the two possible explanations for our three-dimensional mental habit and it happens to be the one that seems most satisfying. But that is no evidence that it is true. To get more light on it let us see if we can imagine how this particular space idea can have grown up in the mind from natural causes and in the course of human evolution.

Success in imagining this process of space-learning by the mind was achieved first, or at least most conspicuously, by the great French mathematician and philosopher, Henri Poincaré. It is necessary, said Poincaré, for the mind to reduce the facts of the world to a certain order if they are to be understood at all. A mere jumble of unrelated sights, sounds, touch impressions and what not would not permit us to think at all. That would be the world-view of an idiot; quite possibly it really is the world-view of the lower animals. Thinking needs more than this. It needs a *frame of reference*, or as some philosophers prefer to call it, a *point of departure;* a fixed frame or a fixed point to which all sights, sounds, touches and other "facts" can be referred in order to fix them in relation to each other and to the mind.

Just so a surveyor setting out to make a map of a new country chooses a mountain peak or a tall tree or some other landmark. This he makes the center of his map. All other objects that he runs across are set down with reference to this. Again, an artist painting a picture cannot paint it in the empty air. He must first get a sheet of paper or a square of canvas on which to place his paints. That sheet of paper is his "frame of reference."

A still better example is that of the postal clerk sorting mail in the post office at some great railway junction. In front of him are hundreds, maybe thousands, of boxes and pigeon holes. Into these he throws, one by one, the thousands of letters that come into his hands. Just so our mind is receiving every instant hundreds of sense impressions that we may call "facts." If these remain unsorted we are idiotic. We are as helpless in the face of the world as the postal clerk would be if he had to take each letter by itself and carry it to its destination. Accordingly, the mind has built for itself, in the long course of human evolution, a set of marvelously complicated pigeon holes in which to sort and classify the facts of life. This is the mind's "frame of reference" for the facts of the outer world. A part of it is the idea of three-dimensional space. Another part of it is the idea of the even and continuous flow of time.

We perceive objects outside ourselves, for the most part, in two ways. One is by the eye, the other is by touch. The visual impression (except for the incidental and later idea of perspective) does not carry any idea of depth or distance, that is of space. It is notorious that visitors to the western deserts of North America, where the air is very clear, are prone to underestimate distances and to set off to reach in an hour's walk some mountain which is really thirty or forty miles away. The eye is an unreliable guide in spacial matters and the origin of the idea of space cannot be ascribed to it.

This origin must be ascribed to the other sense mentioned, the sense of touch. Or rather, it must be ascribed to an outgrowth or accompaniment of the sense of touch, a sense that we may call the "muscular" or "dynamic" sense. To locate an object in space (if it be within our reach) we may touch it with our fingers. To do so we must move our arm. It is this act which gives us the idea of distance. This act, and others like it, develop our muscular sense. They are responsible, it is quite probable, for the creation of the customary frame of reference that we call three-dimensional space.

Our body is so constructed and the relative motions to which we are accustomed have such velocities that the movement of our hand in order to touch something s most simply described as a motion in three-dimensional space. We can move our hands upward, forward or sidewise. All other motions can be described as combinations of these three. There is, so far as we have yet discovered, no simpler way to describe the motions of our hand. And accordingly, since it is another law of the mind to seek always the simplest explanation for anything, we have made our mental frame of reference to fit this simplest explanation of our muscular or dynamic sense developed by the sense of touch. We have built our mental pigeon holes, that is, in the form that we call three-dimensional space.

This may all be dependent, it is well to point out, on the range of relative speeds that we encounter here on earth. For this range of speeds—from zero up to some miles a second—the relativity theory indicates that the famous Newtonian Laws of Motion are a sufficiently accurate description of phenomena. These Laws assume three-dimensional space. If the speeds encountered on earth in ordinary human experience had been many times as great as this, as great, say, as the atomic speeds of fifty thousand or a hundred thousand miles a second, we probably would not have been able to build ourselves this particular three-dimensional reference frame for the facts of the world. The facts themselves would have told us, long since, that the frame was wrong. To return to the simile of the postal clerk, we would have discovered that some of the possible post offices were left out of the frame. There would be an occasional letter for which we could find no place.

Our idea of space, then, has nothing final or fundamental about it. It is merely the frame of reference (or a part of the frame of reference) which we have built up to enable us to sort out the multitude of sense impressions that reach us all the time from the outer world.

This space-frame, it must be remembered, is fundamentally dynamic and muscular. If to reach two objects in the outer world we find it necessary to execute different sets of muscular movements we say that the two objects are spacially distinct; they occupy different "places" in space. In this respect the visual space, as perceived by the eye alone, may be different from the dynamic or muscular space. If we look at two objects which are in the same visual line; for example, at a piece of glass and at some object behind it, and if we use only one eye so that we avoid the possibility of perceiving relative distances by the range-finding action of our two eyes, we cannot distinguish the two objects spacially. They will seem to occupy the same "place" in the visual space-idea that is given to us by this kind of one-eyed vision.

We will have to call in our dynamic or muscular sense. We will have to reach out and touch the two objects, before we will be able to place them properly in our complete three-dimensional reference frame. The occurrence of such uncertainties in real life is avoided, in most cases, by the fact that we have two-eye vision and accordingly an approach to a three-dimensional frame of reference for our visual space as well as for our muscular space. But occasionally, as in the instance of the visitor who underestimates the desert distances, this two-eye space judgment breaks down and then our visual space and our muscular space part company, sometimes with consequences that approach the ludicrous.

The lesson of this is that our space judgment, indeed our whole idea of space, depends on the particular sense that we use to form that judgment—on the senses that man has used in the past to build up his space idea. Three-dimensional space, therefore, may quite easily have been the creation of the physiological and psychological character of man, which is the idea that we set out to establish.

To reinforce this idea still further—for it is by no means an easy idea to grasp—it is convenient to employ the device that we made so much use of in the previous article, the device of fantastic, imaginary creatures whose sense perceptions, worlds and frames of reference are conceived to be very different from our own.

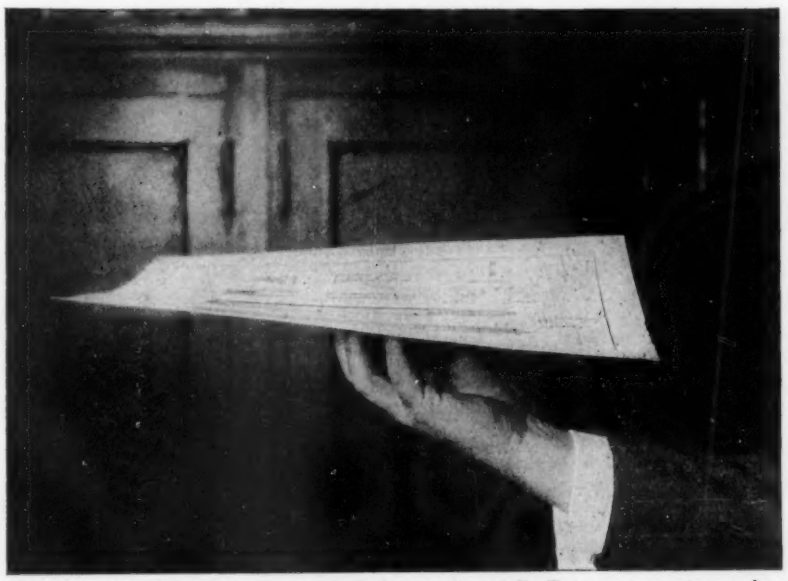
Let us consider a world composed of creatures who exist only in two dimensions, like dolls cut out of sheets of paper. These creatures can move about at will in the flat plane that is their home but they cannot move at all in the third dimension above or below this plane. Furthermore, they cannot be bent, for that would involve moving some parts of their bodies out of the plane to which they are restricted.

But let us grant to these two-dimensional creatures a three-dimensional eye. They can look up, we will imagine, out of the plane they live in into the space above them. They will do this even more fundamentally than we look up at the stars, for our eye has no more dimensional perceptions than our muscles have. We could actually *feel* the stars, we imagine, if but we had a long enough arm.

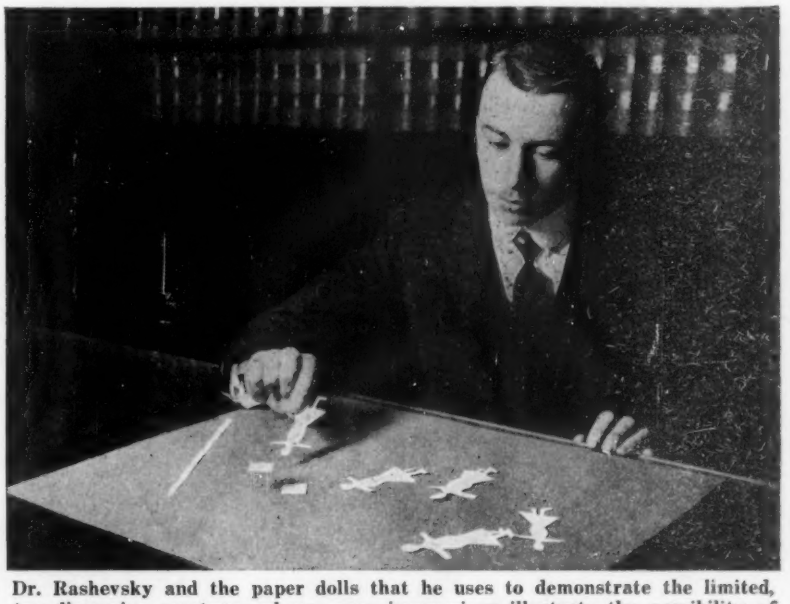
To the paper-doll creatures on the flat plane their outward vision is different. It is an altogether dissimilar thing from their touch sensations that are confined to the plane. It is as though man discovered some day, as indeed he may, an additional sense or sense-instrument that could penetrate the fourth dimension, be it time or be it not, which fourth dimension *may* exist in the reality as a still invisible aspect of the real universe.

Now imagine that there exist in the paper-doll world of our imaginary flat plane two fixed objects; one in the plane, the other just above it. The paper-doll creatures would *see* both of these, but they could *feel* only one of them, the one that lay in the plane itself. Of this second one only would they have any "space conception." They would believe, therefore, that the two objects occupied the same space but that one of them was so constituted that it was imperceptible to their sense of touch. They would believe, in other words, that the two objects differed in what we call "physical" properties.

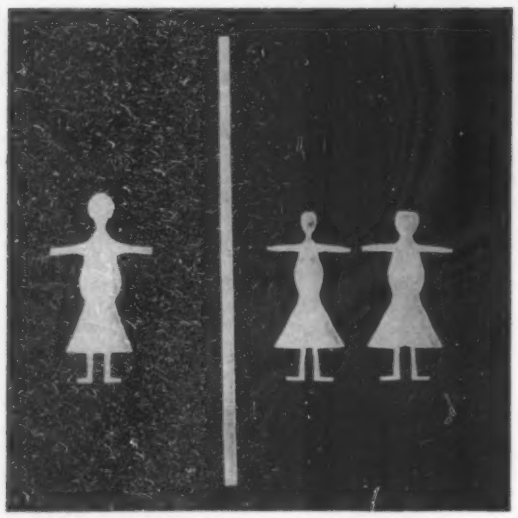
It is possible, we may pause to note, to regard in this same way the common scientific theory of the luminiferous ether. We say that this ether occupies



This is a two-dimension diagram. It has no "space." But you cannot conceive it except as in space. There is space on all sides of it, above it and below it. Try to imagine the two-dimension diagram separated from this surrounding space and you will find that you cannot do so



Dr. Rashevsky and the paper dolls that he uses to demonstrate the limited, two-dimension creatures whose sense impressions illustrate the possibility of different ideas of space and time, ideas that seem utterly fantastic to us, who have our own ideas of these matters



A mere straight-line fence will keep the two-dimension dolls apart. We three-dimension creatures could jump this fence, thus crossing it by passing into the third dimension of space and back again. The dolls cannot enter the third dimension, so the fence confines them. They do not even conceive the third dimension as possible

the same space as other bodies but that it does not affect our senses. If there be any such thing as the ether (which is, of course, a matter of dispute) we might think of it as lying altogether outside the three spacial dimensions which compose our reference frame. Dimly perceived by us in other ways but impossible of being fitted into our mind's idea of the world, this ether may be playing, we imagine, the same role with us that the second external object, seen but unfelt, plays with the paper-doll creatures in the flat plane.

Here again the lesson is that space perception is merely a matter of what sense we use to do the perceiving. It is a matter, that is, of the physiological constitution of the perceiver.

Let us take still another and more striking example of how completely this dictum applies. Let us imagine a kind of creature who cannot move at all and who possesses, accordingly, no muscular sense and no space-frame conditioned by this sense, as we do. But let us grant to these unfortunates one means of contact with their world; let us imagine that they can perceive color. These are the only things they do perceive. And let us imagine that the colors of objects in their world consist of the seven primary colors and of various mixtures of these seven.

Such creatures would be compelled to choose for their frame of reference—their "space"—the color impression. They would have nothing else. If two objects were of the same color the creatures would think of these objects as "located at the same point." And as the color of any object would be determined by the relative amounts of each of the seven primary colors which it contained, the "space" of these color-perceiving creatures would be a seven-dimensional space.

If such creatures really existed in the world as we know it, it is apparent that their idea of the world—their frame of reference for it—would be ridiculously different from our own. It is worth while to remember that *our* frame of reference, our seeming fundamentals of space and time, may be just as ridiculously different from the viewpoint of some creature more richly endowed with senses than we are. It is impossible to say that one of these viewpoints is "right" and that another one is "wrong." They are merely *different*. It all depends on the senses possessed by the particular creature who is doing the perceiving and who is constructing for himself his particular "space" and, it may be added, his particular "time."

Turning now to this matter of time, it is apparent on a little consideration that it, too, is determined by a fact of human physiology. The human body is, among other things, a chemical mechanism. Chemical changes go on in the blood, in the body cells, in the nerve cells of the brain. These changes are what the chemist calls "irreversible," that is the condition of the cells or of chemicals in them is not the same after the change as it was before and cannot be restored to the previous condition by ordinary natural processes.

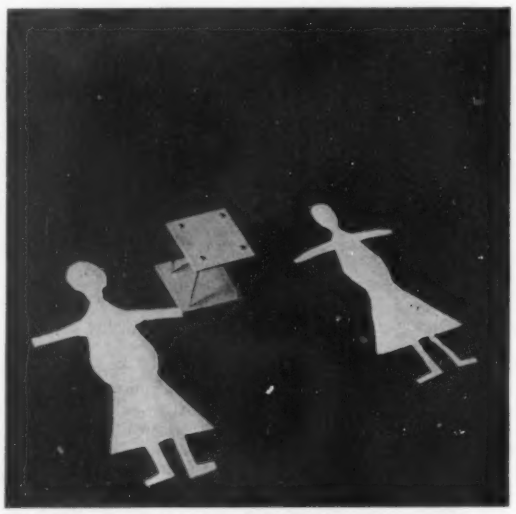
Think of a stick of dynamite. Something happens to make the dynamite explode. What has happened is that the millions of millions of atoms in the dynamite have flown apart. That is an irreversible change. It might be possible, theoretically, to collect all those scattered millions of atoms and to put them together again in the form of dynamite, but it would be difficult. It would require much energy. It would be very surprising if it happened.

The chemical reactions that go on inside the human body are probably quite as violent as is the explosion of a stick of dynamite. The only difference is that they occur on a smaller scale. They are equally irreversible. They are, we believe, the cause of time.

The time idea is essentially the idea of sequence. One thing happens *after* another thing. The chemical reactions inside ourselves do happen after each other. They cannot be reversed. And so, in some obscure physiological way that we do not yet understand, we have acquired the sense of time. We know that the second half of the day comes, as we say, "after" the noon.

And, exactly as has happened with the idea of space based on our muscular sense, so the idea of time based on this physiological time sense has been built into the mind's frame of reference for the world—into the set of pigeon holes by which we sort out facts. It is no more possible for the mind to imagine things outside of time than it is for us to imagine them outside of three-dimensional space. Changes "in time" must occur, necessarily, to objects which exist, we conceive, in space. Conversely, if an object "exists" in space but lasts for no time at all, not even the shortest instant, we refuse to admit that it exists at all.

Every physical event needs for its description a specification of the point in space *where* it happens and of the instant of time *when* it happens. If these two data cannot be supplied our mind begs the question by



The dolls are able, Dr. Rashevsky assumes, to see into the third dimension, although they cannot penetrate it bodily. Accordingly, the small pasteboard square raised above the surface of the plane seems to them to differ only in intangible, so-called "physical" properties from the square placed below it and in the plane

assuming that the event is "unreal" or "imaginary," that is that it never "happened" at all.

Thus the description of any real event requires four independent data; the three dimensions that fix the point in space and the additional dimension that fixes the point in time. The analogy of the time datum with the three-space data is an obvious one and from the purely mathematical point of view it is quite possible to treat all four in the same way. Mathematically, time may be regarded quite successfully as the fourth dimension; which is, indeed, exactly what Minkowsky and his followers have done. Thus one arrives at the "space-time" or four-dimensional world which we mentioned at the beginning of this article.

This viewpoint has proved an especially simple one in the handling of the theory of relativity; which theory consists, it must be remembered, of such complete and rigorous mathematical reasoning that all possible mathematical simplification of the data is especially necessary.

We measure time by means of clocks and all clocks consist, in the last analysis, of some action which repeats itself at regular intervals; as, for example, the rotation of the earth, this being the great standard clock for all the world. But if the speeds of all events inside any given system alter by the same degree there will be no way to perceive this. If all the clocks in your house run slow by the same degree you will know nothing of it until you go out and look at another clock. If all processes in the visible universe were becoming either faster or slower there would be no way to find it out. We would have no standard clock for comparison.

It is one of the tenets of the relativity theory that this might happen and that, in fact, it all depends on the motion of the system that contains the clocks being studied relative to the motion of the observer who measures time by these clocks. Together with this assumption, the relativity theory makes another one concerning the change in geometrical size of bodies as a result of relative motion, and from these two it is possible to arrive at some rather paradoxical results.

It may happen, for example, that two events which appear to one observer as being simultaneous will appear to another observer (who is moving relative to the first observer) as being not simultaneous, and this in such fashion as permits no decision concerning which observer is wrong. Thus two events which one observer sees as happening at the same time but at different places may seem to a second observer to have happened at the same place but at different times.

It was considerations like these which led Minkowsky and the other theorists in relativity to the conclusion that space and time were indistinguishable, both of them consisting of dimensions chosen more or less at random in a four-dimensional world. On this basis the "time machine" of Mr. Wells might seem really practicable. All we would need would be some way of "traveling" along the one dimension that we had chosen as time.

But there is one serious trouble with this point of view. It leaves out man. And a "time machine" would be of little use, humanly speaking at least, unless there were a man to ride it.

Minkowsky claims that the union of time and space into an inseparable space-time whose four dimensions, all at right angles to each other, may be chosen at random, results in a formulation of the universe that is much simpler for mathematical treatment than our more familiar plan. This is quite true. We do gain in simplicity—always the object of science—if we are describing certain basic physical phenomena such as those with which the relativity theory is so especially competent to deal.

But it is possible that we will lose in simplicity in describing the phenomena of mankind and of the human mind. These human phenomena involve the physiological and psychological organization of man. Out of the muscular sense of man has come the idea of three-dimensional space, that being the simplest way in which we can interpret the data that we obtain by touching external objects. Out of the chemical changes that go on irreversibly inside the human body the mind has made the distinction of past-future and has built up the idea of time. That, too, seems to be the simplest way in which we can conceive, at present, the facts which find their fundamental human expression in the observation that we live, grow old and die. For thinking about ordinary things there is no simplification in rejecting these natural (natural because fundamentally human) ways of thinking in order to embrace the mathematical reference frame in which time and space are indistinguishable.

With the progress of science we may be able, some day, to do this; to find some more complete sense per-

(*Concluded on page 446*)

This photograph illustrates what the creatures of the doll world might consider to be an angel. The paper doll held above the two-dimension plane of this fantastic world is visible to the doll creatures, but cannot be touched by them or examined in any other way. It seems to them what we call a "vision"

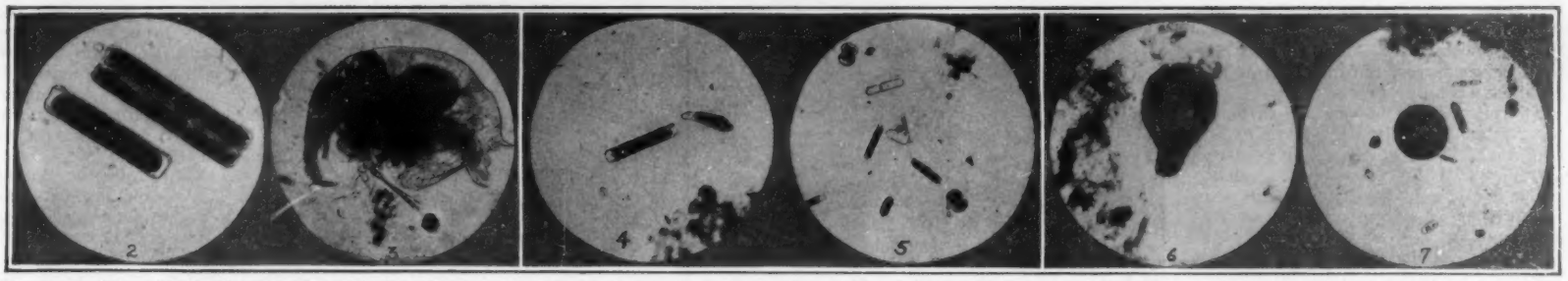


Fig. 2: A diatom (Diatoma), an important food producer for the larger protozoa and crustacea. Fig. 3: One of the smaller crustaceans (Bosmina), an important element in the food of fish fry, and of the larger fishes as well. Note the large egg in the brood case of the dorsum. Fig. 4: Left, a diatom (Diatoma), and right, a green flagellate protozoan (Euglena). Fig. 5: In the center, a group of diatoms, and above and below, two large desmids. Fig. 6: Shell or test of Difflugia. Fig. 7: Shell of Arcella. Near the latter can be seen several desmids and diatoms upon which both of these forms feed. Arcella and Difflugia are rhizopods

Various kinds of plankton organisms which form the basis of aquatic life

The Basis of Aquatic Life

Some Significant Phases in the Study of the Plankton of Lakes and Seas, and What They Mean to Us

By Dr. Leon Augustus Hausman

Research Zoologist and Instructor in Zoology, Rutgers College

WE are accustomed to regard the sea as a singularly lifeless and barren place. Our popular conception is embodied in such expressions as: the barren waste of waters, the desert expanse of sea, and the like. And yet the fact is that nowhere on our globe does there exist a more numerous assemblage of animal and plant forms than in the upper layers of the waters of our oceans and seas. So multitudinous are these living forms that a single tumblerful of water drawn at random from the surface of any lake or sea, may contain hundreds of thousands of individuals, and yet the whole company be invisible to the unaided eye, or at most, impart but a slightly cloudy aspect to the water.

In all large bodies of water, both salt and fresh, there exist in the upper layers, a vast host of living forms, collectively known as the *plankton* (Fig. 1). They are minute, transparent or translucent, and of a delicacy of structure which enables them to float without exertion. Some of these are plants, some animals. The plants are represented chiefly by the algae, the lowest and most lowly-organized vegetable forms. Of the algae the most numerous are the desmids and diatoms, notably the latter (Figs. 2 and 5). The desmids and diatoms are nearly all single-celled forms, numbering many thousands of species.

The plankton desmids and diatoms float freely in the upper strata of the water, being buoyed up by oil globules within the cell, and, in the presence of sunlight, manufacture food from the inorganic materials held in solution in the water. This great class of planktonts is, therefore, of primary and radical importance in the support of all other plankton life, even as are the plants of the land surface in support of terrestrial existence. The diatoms, the most largely represented in the one-celled algae group, are enclosed in shells, or valves of silica, which, being practically indestructible, sink to the bottom after the death of the cell, and there form the deposits known to the geologist as diatomaceous earth. Such deposits, when rich in silica, as they frequently are, have become of considerable commercial importance either as polishing powders, or as absorbents of nitroglycerine in the manufacture of dynamite. Some few filamentous algae, similar to the green "pond scums" are likewise found in the plankton, especially in the smaller lakes. They are, however, relatively of little moment in the alimental economy of the life of the planktonts.

Bacteria and parasitic fungi are invariably present wherever other organic forms are to be found. Little is known at the present time concerning the plankton bacteria.

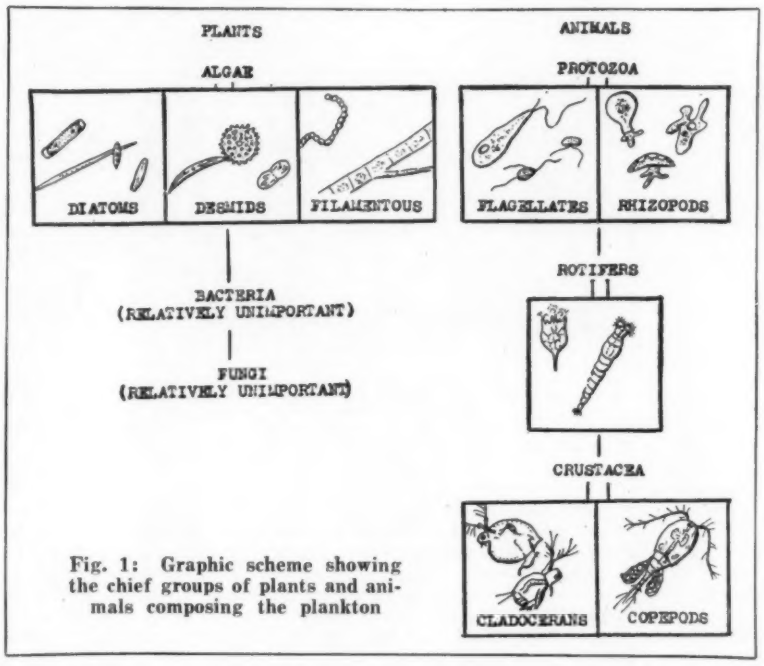


Fig. 1: Graphic scheme showing the chief groups of plants and animals composing the plankton

The rôle which they play in the life of the open waters is, probably, similar to that of the forms with which we are familiar in the processes of decomposition. Neither the plankton bacteria nor the fungi appear to be of much importance in the maintenance of plankton life.

The animals of the plankton are chiefly the protozoa, rotifers, and crustacea (Fig. 1). The protozoa are comparable, in organization of body and position in the animal kingdom, with the desmids and diatoms. They are minute, uni-cellular forms, and are possessed of some fairly efficient means of locomotion. Many of them, like the Euglena (Fig. 4) contain chlorophyll, and hence are able not only to construct their own food from inorganic materials, but also aid in producing an available foodstuff for the larger, herbivorous forms. Figs. 6 and 7 are photomicrographs of two of the commonest of the fresh-water protozoans. Although they are provided with a fairly dense shell or test, they are able to float at or near the surface by reason of included air or oil. Such forms are phytophagous, or plant-devouring, and are, themselves, an important element in the food supply of the larger crustacea, and fish fry (Fig. 11). The rotifers and crustacea are the largest of the planktonts. The former (Fig. 1) are of especial interest to students of aquatic life because of their affinities with the worms, and also because of the many problems in life history and anatomy which they present. In the plankton they act the part of carnivors, and transform smaller organisms into food available for larger ones. The crustacea represented in the plankton are distantly allied to the familiar lobsters and crabs, and nearly all of these grow to sufficient magnitude to be seen with the naked eye. They form the chief food of many species of fishes (Fig. 3).

Within this unique circle of the life of the open water we find a society of creatures which is self-sustaining, and entirely independent of the life of the land. It contains within itself all of those elemental groups found in any complete and self-perpetuating animal society: producers, consumers, scavengers, parasites, and the like. No other group of animal and plant forms lives in an environment of such homogeneity. It is doubtful if there can be found anywhere else a community of organic beings in which the vital economic balance has reached so precise and undeviating an adjustment.

All this is very interesting, you say, but is it of importance? Of the greatest importance; not only for the biological sciences, but practically as well. For in the study of plankton we are considering a group of creatures which forms the basis of the entire life of our seas and lakes. It is the great feeding ground for fishes, or for those forms upon which the fishes depend for food. And the fishes, in their turn, provide the necessary food supply for the aquatic mammals; the seals, whales, porpoises, and others. Eliminate the plankton and all aquatic life would cease to be.

The minutest of the plankton, the desmids, diatoms, and green flagellates may be likened to the meadows of the land. They are the primary foraging ground, consuming inorganic elements and producing food for the herbivors. Smaller feeds upon larger, is the general rule, and so the life of the water is maintained. It is interesting and noteworthy in this connection to recall that the largest creature, bulk considered, of which we have any rec-

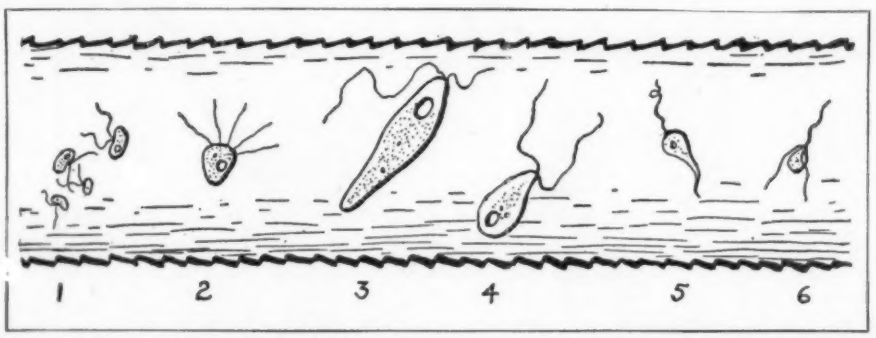


Fig. 8: Some of the smallest of the plankton organisms, represented as lying upon the shaft of a human hair which is approximately 50 microns in diameter. 1. Pleuromonas. 2. Strombidium. 3. Rhyncomonas. 4. Dinomonas. 5. Cercomonas. 6. Elvirea

ord in the history of our earth, the huge Blue Rorqual Whale (Baelenoptera musculus), feeds very largely upon the smallest creatures, the members of this plankton group.

The plankton organisms are variously distributed in the upper strata of the water. Light is, of course, the controlling factor in their distribution. Hence we find the majority of the species near the surface, say from about three feet below the top to some ten or fifteen feet below that, the distribution varying with the clarity of the water. Planktonts are found, in some localities, however, as far beneath the surface as sixty or seventy feet. Temperature exerts, likewise, an influence in plankton disposition. And curiously enough it is not in the tropical seas that one finds the richest and most abundant plankton life, but in the polar ones!

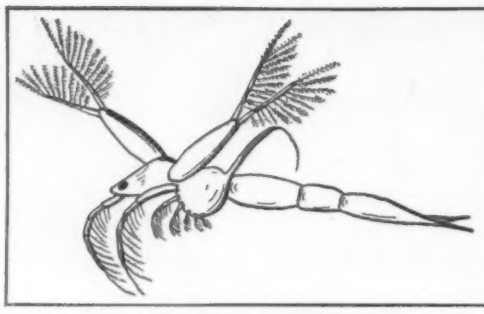


Fig. 9: Leptodora, a crustacean, one of the largest of the plankton forms, which may reach an inch or more in length

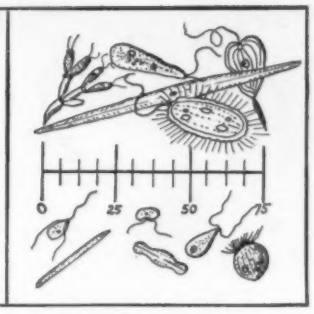


Fig. 10: Various specimens of plankton grouped about a scale reading in microns

The planktonts themselves are virtually unable to regulate their dispersal over large tracts of water, for although many of them are provided with locomotor appendages and are capable of voluntary and directed movement, whatever swimming they accomplish is of a rather ineffective sort and serves to move them only through comparatively minute distances. They may rise or sink, and thus seek their optimum levels, but are dependent upon tides, winds, and water currents for their broad general distribution.

The mere physical quantity of plankton life contained in any given volume of water is surprising. It has been estimated that the total bulk of such life in an average lake is probably equal to the total bulk of life produced over an equal area of an average land surface.

In size the majority of the planktonts are so small as to lie below the range of vision of the unassisted eye. The smallest of the forms are the bacteria, which strain the powers of even the best of our modern microscopes; the largest are the crustacea. Roughly the upper and lower limits of magnitude may be found among the animal forms. The smallest of these is the *Pleuromonas* (Fig. 8, No. 1), with a diameter of from 2 to 9 micra (See Hausman, L. A., the Smallest Animal in Existence, SCIENTIFIC AMERICAN Monthly, May, 1921). The largest is the Leptodora, a crustacean reaching an inch or more in length (Fig. 9). Exclusive then, of the bacteria, the smallest organisms of the plankton are the flagellate protozoa. A group of these is shown in Fig. 8, represented as lying on a section of a human hair, which is approximately 50 micra in diameter. The micron, the unit of micro-mensuration, is 1/1000 of a millimeter, or about 1/25,400 of an inch.

Upon the basis of size the planktonts have been divided into two fairly distinct groups. These we shall term the macroplankton and the microplankton. The former are sometimes called the net plankton (since they may be taken with a fine silk net) and the latter the nannoplankton (dwarf plankton). The macroplankton are those above 25 micra in diameter; the microplankton those below (Fig. 10). The group containing the microplankton is by far the larger of the two, being, by weight, on the average from three to ten times as great. In this group there occur chiefly the bacteria, some of the algae, and nearly all the flagellate protozoa. The study of these minute forms is most difficult, and calls for apparatus and manipulation of extreme nicety (see Hausman, L. A., The Manipulation and Identification of the Mastigophora of Fresh Waters, Am. Nat., vol. 54, July and August, 1920). Within the macroplankton occur the rotifers, crustacea, and the larger desmids, diatoms, and protozoa.

The macroplankton are ordinarily taken with the plankton net (Fig. 13). This is composed of fine bolting silk, and when drawn through the water strains out approximately from 35 to 50 per cent of the organisms in the column of water which passes through it. The plankton net is towed behind a boat, and the depth at which it travels can be regulated either by weights, or by varying the speed of the boat. At intervals the net is hauled aboard and its contents rinsed into a jar. Or the water may be pumped through the net either by hand or by machinery. The latter method of securing plankton is employed where it is desired to carry on investigations of a quantitative sort over a large area. In the ocean metal nets are often used, encased in torpedo-shaped tubes, in order that they may be drawn at rather high speed behind steamers. Numerous modifications of all of these devices are to be found in various laboratories.

For the capture of the microplankton an apparatus known as the water-bottle is used. This is merely a large, small-mouthed flask attached to a rope. Along

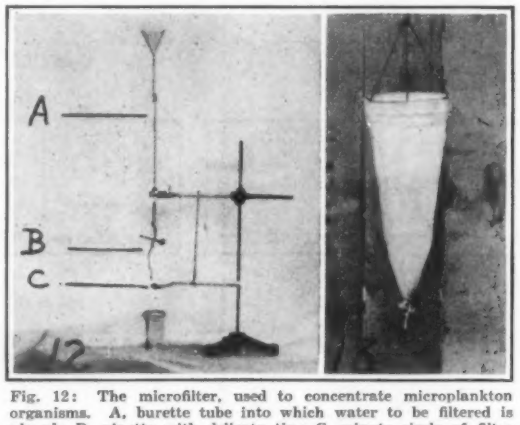


Fig. 12: The microfilter, used to concentrate microplankton organisms. A, burette tube into which water to be filtered is placed; B, pipette with delicate tip; C, minute circle of filter paper. Fig. 13: Plankton net drawn behind a boat; used in the capture of macroplanktonts

Two of the tools of the student of minute aquatic life

the rope are markers spaced at the interval of one foot, so that one may know accurately the depth to which the bottle is lowered before the sample is taken. When the desired depth has been reached the cork is pulled from the bottle by a second rope, and the bottle allowed to fill. It is then withdrawn, the sample bottled and labeled, and is ready for the collection of another sample from a different depth.

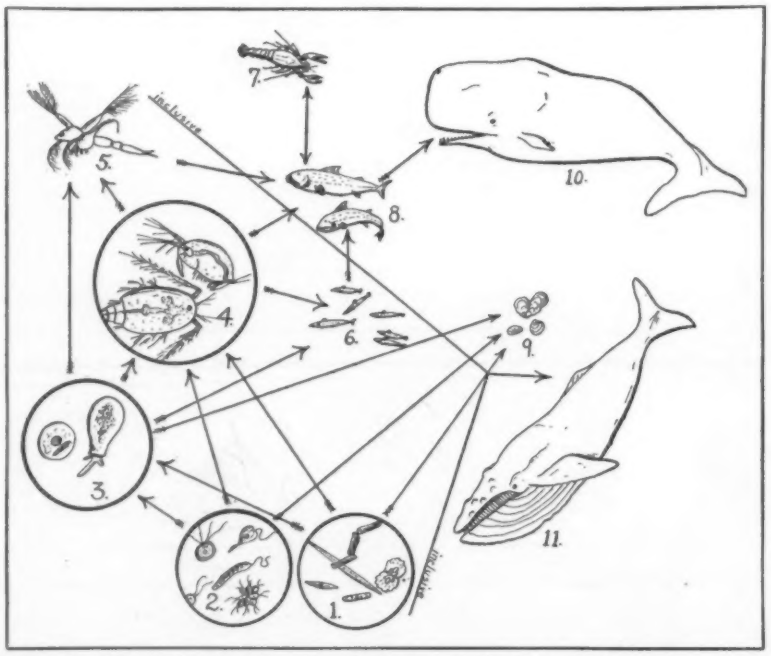


Fig. 11: Chart showing the alimental inter-relationships of the various great groups of food supply, the arrows in each case pointing from consumed to consumer

Upon arrival at the laboratory the samples are filtered through a tiny piece of hard-surface filter paper, and the residue washed off into a known quantity of distilled water. Fig. 12 shows an apparatus designed by the writer, and known as the microfilter, for quantitative studies of microplankton.

A great deal still remains to be learned about the microplankton. The small size of the organisms renders their collection and study difficult and exacting. Curiously enough, it is among the algae group that one finds today the smallest and the largest—or, at any rate, the longest—of living plants. Thus the bacteria stand at one extremity of size, and the giant kelp (Macrocystis) of the Pacific at the other. The latter has been known to reach a length of 900 feet! And both of these, the vegetable Lilliputian and the vegetable Titan, are to be found as near neighbors in virtually the same habitat.

Can we cultivate plankton in our lakes? For if we can, we can also cultivate our rapidly decreasing supply of fresh-water fish food. In many of our smaller inland bodies of water a once copious and important supply of fishes has failed, or is failing, and chiefly because we have allowed pollution of the water to take place, killing entirely or greatly reducing in numbers the members of the plankton. The first step in the repopulation of our depleted waters is the cultivation of its plankton growths. Stocking the water year after year is futile unless this be done.

It is because of this very intimate relationship of planktonology with one aspect of our conservation of an important element in our food supply that this comparatively new field of study is receiving the attention of students both of aquatic biology and pisciculture.

Attacking Malaria With Airplanes

TALLULAH, Louisiana, is Federal headquarters for studying methods of boll weevil control and Mound, Louisiana, a few miles from Tallulah, is Federal headquarters for studying malaria control. The same airplanes are serving both these stations in efforts to poison boll weevils and mosquitoes.

The larva of the malaria mosquito is a surface feeder in the water where it is bred. Because of this feeding habit it can be attacked with poison. It has been found that a pound of paris green can be applied so as to effectively treat 20 acres of swamp. This has been demonstrated by Dr. W. V. King, who is in charge of the malaria work at Mound. In this demonstration the poison was, however, put on with a hand machine operated on the ground. From 90 to 95 percent of the larvæ of the malaria mosquito was killed by this treatment.

The instant the poisoned dust particle comes to rest on the surface of the water and before it has time to sink, a mosquito larva pounces on it as if it were food, with the result that it gets its fatal dose of poison.

The fact that malaria mosquito larvæ could be poisoned having been established the question arose as to how to spread poison over cyprus swamps, mud flats and other inaccessible places, the answer to which is being sought in the use of the airplane.

The first year of airplane testing has met with sufficient success to hold out bright promise. In spite of dense foliage of the cyprus swamps dust spread by the airplane percolates through to the water in sufficient quantities to cause high mortality among the larvæ. More poison, of course, is required for forested swamps but not so much more as to make airplane poisoning impracticable.

Only the malaria mosquito is killed solely because of its distinctive feeding habits.

Further experimentation will be required to determine the most effective dosage under varying conditions of the mosquito's habitat, also to learn if there are better mechanical attachments for the airplane than are now being used for dusting. But enough has already been learned to encourage the belief that airplanes may carry "healing in their wings" to vast regions of the country now subject to the chills and fever and general discomforts of malaria.

Inventions New and Interesting

A Department Devoted to Pioneer Work in the Various Arts and to Patent News

Conducted by Albert A. Hopkins

Don't Be Shocked

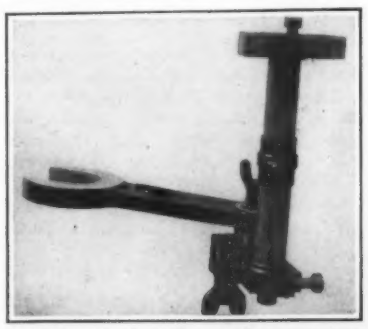
THE danger of getting a serious or fatal shock if you work around electric circuits of any kind is no joke. No matter how old a hand you are, you are

A special rubber insulating glove and sleeve designed for the protection of those who do electrical work or for workers in acids

always in danger. In fact, if the adage that "familiarity breeds contempt" still holds, you are more liable to "get it" the longer you stay in work of this sort. There is the rule to keep one hand in your pocket while doing work of this sort, but like many another rule this one works out quite well for the other fellow. If you do work of this sort you will usually have to use both hands.

A Newark, New Jersey, manufacturer has provided special rubber, insulating gloves and sleeves for the purpose of protecting electrical workers from shock. The gloves or mittens are made in lengths from 11 inches up to 18 inches long and are designed to guard against various voltages ranging from 3000 to 15,000. The sleeves go on over the gauntlets of the gloves and protect the wearer from the wrists to the shoulders. At the upper end there is a grommet and hole, so that the sleeves may be tied on by means of a rubber band, permitting stretch in work.

These sleeves are also adapted to the use of workers in acid as well as in electrical work. For the latter use they have all the electrical and mechanical qualifications required by the N. E. L. A. breakdown test on sleeves—30,000 volts.



A device for locating and measuring vibrations in turbo-electric machinery may be clamped to any convenient part of the machinery under test

The Vibrometer

TURBO-GENERATORS, revolving at very high speed, are often subject to baffling vibrations which in the interest of safety must be located and properly remedied if trouble is not to arise. Usually when a small amount of vibration is noted it may safely be predicted that it will increase itself. Centrifugal force varies directly as the square of the velocity; therefore, even an extremely small unbalanced weight will, when set revolving at the high velocities of the steam turbine, set up stresses that are comparatively high.

The vibrometer is a delicate instrument for catching up incipient vibrations in machinery of this and allied kinds. By its use the source of the vibration may generally be located. Its design is based on the tuned vibrating reed principle. In making observations the reed is tuned to respond to the particular vibration under examination, and great sensitivity is thus obtained. Means are provided for turning the instrument about both its vertical and horizontal axes till the maximum amplitude is found, the angles being indicated on the scales provided. The weight of the instrument is two pounds.

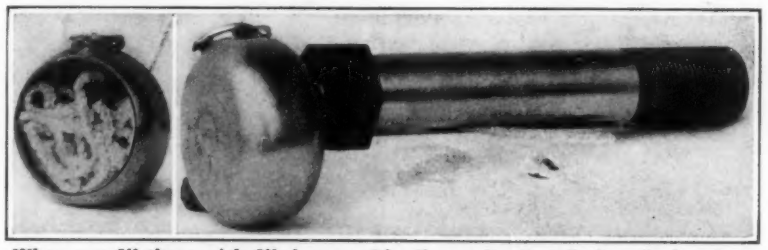
Referring to the illustration, the long, slender vibrating reed which shows in darker relief against the column is slightly loaded at the free end and is clamped at its lower end in the jaws near the base. The movable spring clamp slides friction tight on the pillar and carries a marker operating over a scale. The pillar can be set so that the plane of vibration of the reed is in any angular position, which position is indicated on the scale at the lower left. The instrument is clamped to any convenient part of the machine under test. When the sliding bushing on the pillar is in the right position so that the reed is tuned, the frequency is read off. Reeds of different thickness may be used at different speeds, three reeds thus adequately covering the range from 300 to 1500 r.p.m.

This accurate instrument is the product of a Glasgow, Scotland, manufactory and appears to be as carefully made as British tradition demands.

Chassis Oiling with the Gravity-Capillarity Wick

CHASSIS lubrication is a vexing problem. The average motorist is overconscientious about it with his new car and not conscientious about it at all after the first thousand miles. That is one of the reasons why shackle bolts are always squeaking and wearing out. Grease and oil make fine lubricants if they are regularly supplied. It is easy to keep supplying grease to a grease cup, but it is harder to insure that it will always be on the sore spot in the rub. This is especially true in cold weather.

A Chicago manufacturer believes he has solved this problem by finding a practical way to keep oil—not grease—in the shackles all the time. As shown in the illustration, this is done by means of saturated wicks which equalize supply and demand in the oil business where it concerns the wearing parts of the chassis. When you fill these cups gravity first flushes the bearing clean; then capillarity conveys oil steadily through the wick to the bearing surface. This identical principle has stood the test of time in oiling railway truck journals. The cap is dustproof and watertight, and it is claimed by the manufacturer that these oilers will keep oil going to the right place for 3000 miles.

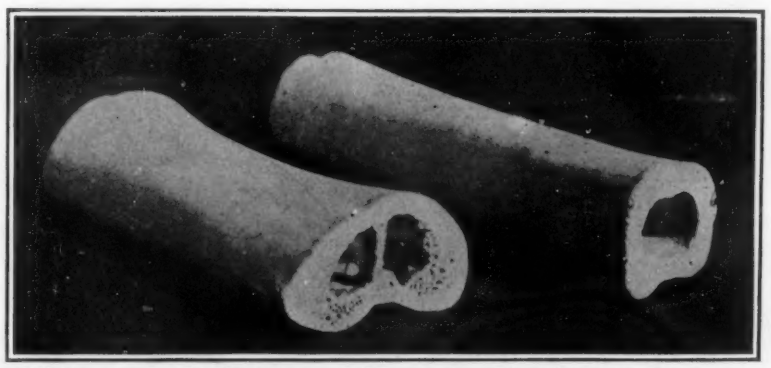


When you fill these wick-filled cups with oil, gravity first flushes the bearings clean; then capillarity conveys oil steadily through the wick to the bearing surface. This same principle has stood the test of time in oiling railway-truck journals. The cap is dustproof and watertight

Chicago to the Rescue

NOTHING is ever wasted at the Chicago stock yards, but recently there has been an unparalleled call for shin bones for exportation to China for making Mah Jong sets. Such bones are now an important article of commerce and are sent to China by the ton. These are used in connection with bamboo to form the "tiles" in the Mah Jong set.

China does not have many domestic animals and, therefore, is not able to supply the ever increasing demand.



Shin bones of cattle, like the ones pictured above, have become a large commercial product. They are shipped to China by the ton where they are used in the manufacture of Mah Jong tiles

A Useful Floor Lifter for the Handy Man Around the House

HAVE you ever had to rip up a section of tongue and grooved flooring? Was it a pleasant job? Did you not wish you had a larger chisel than exists?

A handy tool for cutting tongues of old flooring

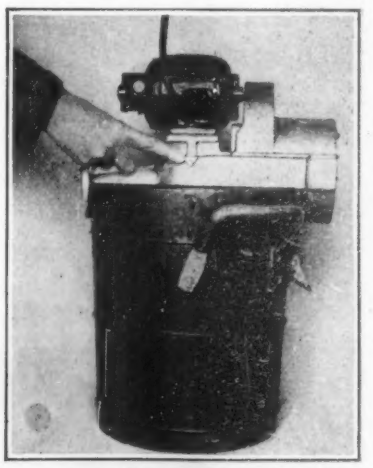
On this page we illustrate, not such a chisel, but such an implement having a five-inch blade. The illustration is almost self-explanatory. Simply insert the blade between the floorboards and use the hammer. You thereby cut five inches of tongue at a time. The implement seems to be heavily made and should "stand the gaff."

Electricians, contractors and other trade artisans, not to speak of the handy man around the house, find such a tool very useful. It speeds up work and saves dispositions, for no one likes to drive sharp chisels against nails over joists.

This tool is made by a New York manufacturer.

Ice Cream Freezer Stops Itself When Cream is Frozen

AN electric ice cream freezer with an automatic indicator for cutting off current when the contents are frozen to the degree desired is the device pictured here.



A freezer that stops itself when cream is frozen

It connects to any electric lighting circuit and freezes frozen custard in seven minutes and ice cream in twelve minutes.

The speed can be equalized to meet the precise requirements of its contents and, once set, it mechanically performs its duties.

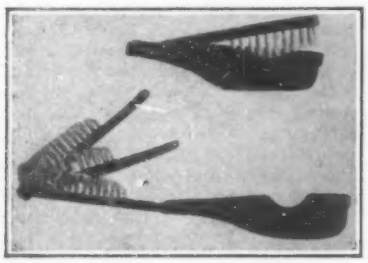
Note that the motor and the cross arm are combined.

A time-saving device for lacing up the fowl

Automatic Lacer for Fowl

ANOTHER useful and time-saving device to simplify housekeeping is an automatic lacer for sewing the fowl together to keep the dressing in.

Grandmother had to use a needle and a stout thread, a messy job at best. The modern housekeeper merely inserts aluminum pins on which the string is laced back and forth. When the fowl is done to a turn, the withdrawal of the pins automatically releases the string.



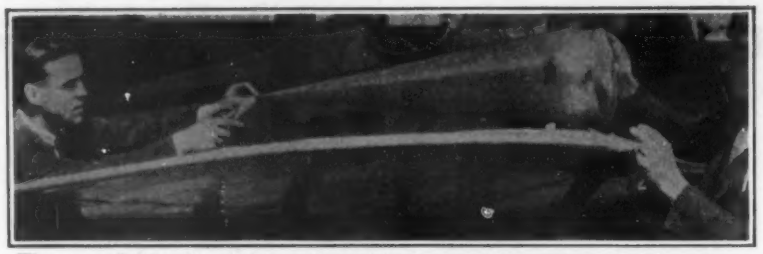
An unusually sanitary toothbrush

A Toothbrush with Accessible Bristle Roots

A HYGIENIC device is the toothbrush shown on this page, in which the roots of the bristles swing out from the base thus facilitating their thorough cleansing and flushing with water.

The brush has three rows of bristles, each of which swings out separately.

In this design of table accessory the pepper and salt container, usually made separately, are welded together but they can be used independently



The powerful landing lights with which planes of the western division of our mail service are equipped

A Trouble Light with Interesting Features

THE trouble light shown in the photographs at the bottom of this page is plugged into the socket of a headlight, tail light or dash light and a ten-foot cord makes it possible to use it at any part of the car. A heavy spring clip makes it possible to fasten the light to any projection on the car and by this means both hands are left free.

Rubber tubing placed on the clip prevents the polished surface from becoming scratched.

Landing Lights for Mail Plane

'NIGHT EYES" for pilots flying United States Air Mail planes have been installed recently on all planes in the western division of that branch of our mail service.

The new lights are placed on the ends of the lower wing and are of 450,000 candle-power each.

From an altitude of five hundred feet these lights light up landing space for an area of over half a mile, and are an invaluable aid to pilots who must make landings at night.

A useful device for changing films or plates, or to take on trips away from home. This may also be used as a focusing cloth

Portable Dark Room for Photographers

A BAG for changing plates or films is a useful device for home portrait work or to take on trips. It is made of a special rubberized material and when folded will fit into any camera case or the camera may be wrapped in it.

The photograph on this page shows how the bag slips over the head and fastens around the waist.

The small square is the ruby light for daylight or night work. It is thirty-six by thirty-six inches and may also be used as a focusing cloth.

Felling Large Trees Baffles Inventors

THE big trees of the west have so far baffled all efforts of inventors to supplant the oldtime "bucker"—the strong-armed man who saws them through.

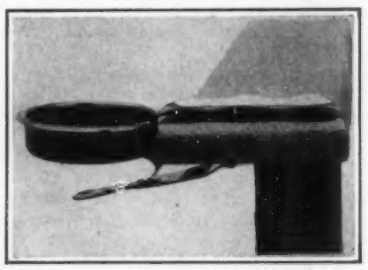
The tree shown in the photograph at the top of the page is 220 feet high—as tall as a twenty-story building—and the first branch is 150 feet above the ground.

If any of our readers know of any mechanical device that has been used successfully for work of this kind we would appreciate full particulars and photographs.

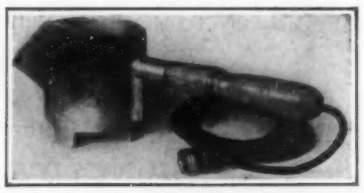
Two old-time "buckers" cutting down one of the giant redwoods of California

An Electric Melting Ladle

THERE are many industries which require more or less constant use of melted materials, such as battery compound, babbitt for bearings, wax, etc., and, in addition, there are thousands of people who occasionally use them on small jobs of various kinds. Keeping the material liquid is generally a good deal of a bother and diverts one's mind and energies from the work itself. Under such circumstances the electrically heated hand ladle is a blessing undisguised.



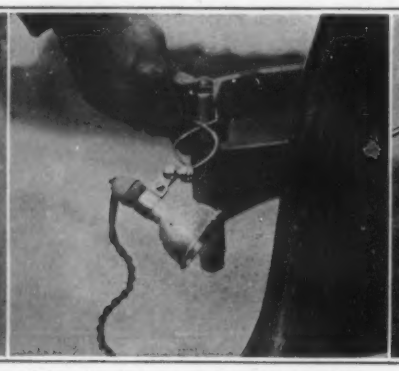
A snap-on ash tray that should appeal to the bridge player or smoker. It may be attached to a table or the arm of a chair



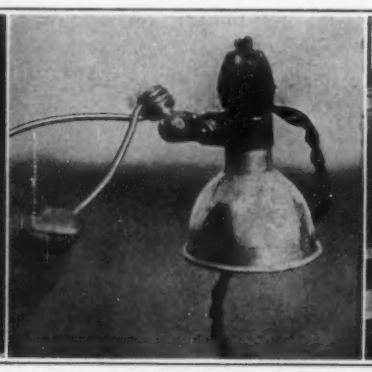
An unusually well designed electric melting ladle

The little ladle illustrated on this page is manufactured in Philadelphia and is designed to be highly useful. Whoever designed it evidently spent considerable time over details and had an eye for neatness as well as utility. The bowl is of aluminum—therefore, it is light, facilitating careful pouring.

The lamp is easily attached to a fender or bumper

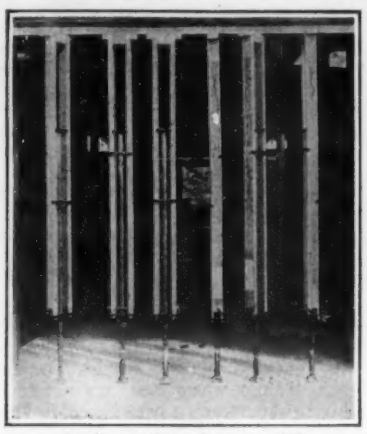


The simplicity of the lamp makes it useful in many places



It is possible to turn the lamp in any desired direction

Repairs or adjustments may be made at night with little trouble

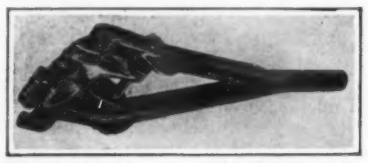


A shore that fits any job

The Adjustable Shore for Concrete Work

MODERN concrete building construction requires the fitting of many shores, in order to hold up the forms. The old method of doing this sort of thing was simply to use two-by-fours, and to wedge them up. Of course, they had to be cut to fit within a quarter of an inch or so and all in all, the waste of timber and labor was great.

Up-to-date contractors now use patent adjustable shores which are as good in one place as in another and can be adjusted to fit in any place within a few seconds. Such shores are set up by a jack, so that the right pressure under the forms can be maintained and sagging



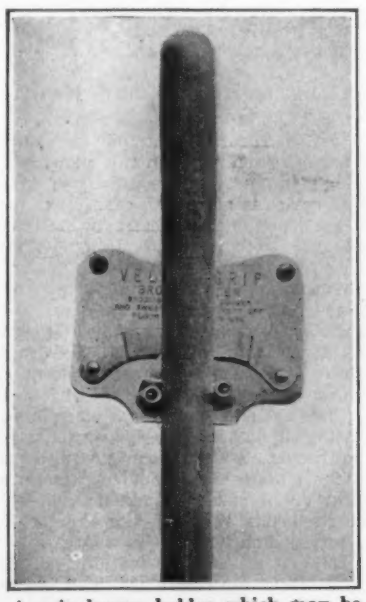
The jack slips on and off instantly

forestalled. The shore consists of a wooden frame and a cylindrical iron tube with automatic jack. Such a shore is illustrated on this page and its simplicity is apparent at a glance.

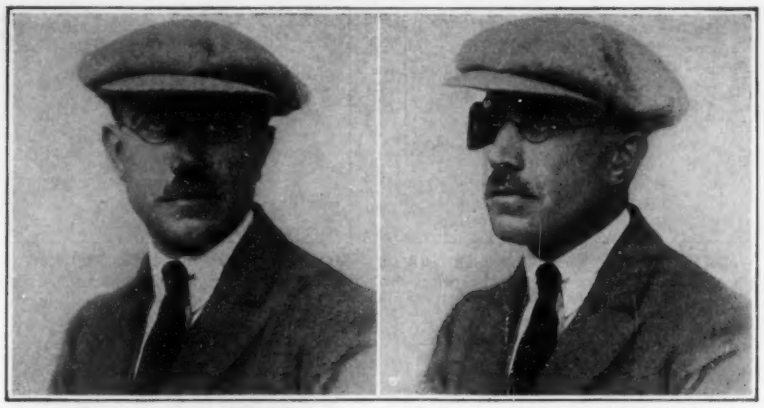
The shores are eight feet long when collapsed, but there is a six-foot adjustment, so that 14 feet is the extreme extension possible. They weigh 65 pounds, just a nice shoulder load for one man. They are so simple that green labor can work them, and since there are no loose parts, the unit can be kept together in spite of careless workmen.

The jack contains a grip of the pipe-wrench sort. This jack is not meant to be kept with each shore, but rather to be attached to each while it is being adjusted. The jack simply does the jacking, while the jaws of the shore keep on holding to the rod after the jack is slipped off.

Doubtless there are many places besides concrete work where these shores would be found to be invaluable.



A grip broom holder which may be screwed on the wall in any convenient place. It prolongs the life of the broom by keeping it from resting on the floor



A simple device which cuts out the glare of approaching headlights

Do Approaching Headlights Dazzle You?

HEADLIGHTS dazzle most people, and the worst aspect of it is, there's little that can be done about it, for the roads are far too congested nowadays for each driver to switch off his headlights when approaching another car.

Mr. Frederick Dalton, of Birmingham, England, has solved the difficulty, however, by applying to an ordinary spectacle frame a small, thin shutter. This is attached to the eye that is furthest from the passing car, which in the case of Great Britain would be the left eye, but elsewhere, the right.

On approaching a car with headlights shot squarely at you, simply turn your head a trifle until the eye is in shadow. Then the road may be seen as before. The other eye may be kept open till almost the last second or two—or you may close it sooner. The whole operation gets to be second nature in a few minutes.

The device is so simple that wearing it is not inconvenient, and its use saves a great deal of eye strain, for the eye otherwise keeps trying to accommodate itself to extreme brilliance, followed by the reverse.

The Kerosene—Not Gas—Water Heater

THERE'S the old tale about the unscrupulous dealer selling the farmer's wife a gas stove. But he couldn't sell her the necessary gas.

You don't have to live in the country, however, to find use for a kerosene hot-water heater. Cottagers like hot water as much as do townspeople. There is a way to have it—a new device manufactured in the general image of the regular gas hot-water heater.

The tank of this heater, which is made in Cleveland, Ohio, is doubly insulated, keeping the heat inside where it is wanted and thus turning it into a conservator instead of a radiator.

The heater is provided with a thermostatic shut-off. You light the burner and forget it (you generally do anyway). Then when the tank is full of hot water the thermostat automatically turns off the flame. Half an hour, according to the manufacturer, gives an abundance of water for a bath.

The burner is one which, it is said, four million women are using today in oil stoves because of its cleanliness and dependability. The two objects on right and left are oil containers having one gallon capacity each.

The steel tank itself holds 30 gallons. It has a hollow center which houses the spiral, 28-foot copper heating coil.

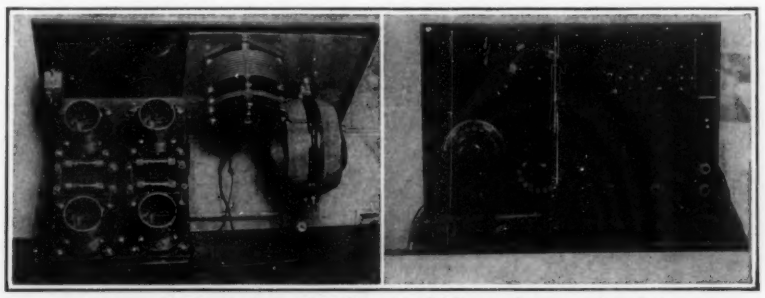
A Radio Set That Uses No Rheostats

THE radio set shown in these photographs is not only extremely simple to operate and very well designed, but is especially interesting because no rheostats are used.

It consists of one stage of radio frequency, detector, and two stages of audio frequency but, instead of the usual rheostats, automatic resistances are used. These resistances resemble grid-leaks.

Any kind of tubes or "A" batteries may be employed with the same resistances.

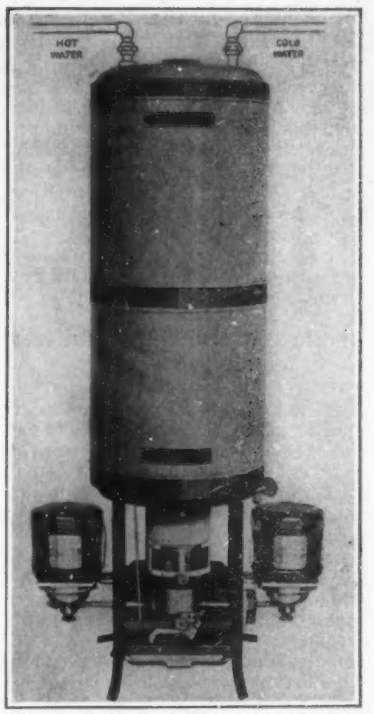
As the modern trend in radio is to reduce the number of controls this set should be of special interest.



Rear and panel view of radio set which employs no rheostats

The Skilsaw

WITHIN recent years we have seen the small-sized, portable electric motor applied to all manner of special tools, the main purpose being to speed up work and take the place of help that is no longer available in numbers as was once the case. Here we see a particularly interesting application of this sort. This handy little tool is driven



Heats water just like a gas heater

by a one-horsepower motor by means of power taken from the regular electric light circuit through a flexible cord. Its weight is 12 pounds, its length 19 inches, and the saw is 8 inches in diameter.

This handy little tool is driven by a one-horsepower motor by means of power taken from the regular electric light circuit

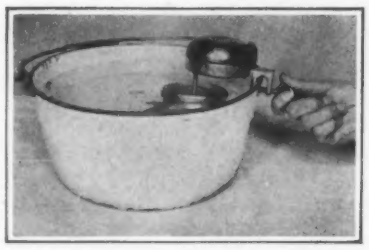
In place of the saw, an abrasive disk may be used, if desired. The saw may be used for a large number of materials of wide variety. For instance, fiber, bakelite, sheetrock, wall board, steel, bones, copper, lead, slate, hard rubber and lumber. In hard pine this saw will either rip or crosscut on an average of two square inches a second, according to the claims of the manufacturer.

This beater will fit any one-quart mason jar and may be used to beat eggs or whip cream by simply pushing up and down on the handle

An Alarm for the Refrigerator Pan

BY a simple device the problem of an overflowing ice-box pan is at once solved. All that is necessary is to attach this alarm to any pan and, when the water rises to the level set, the float to which the alarm bell is attached is pushed up to the point where it will start the bell ringing and thus give ample warning.

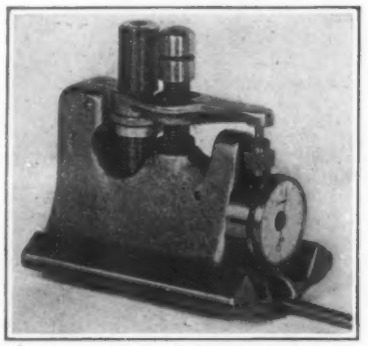
The pan can then be emptied and the alarm rewound to act as a reminder on the next occasion.



With this alarm the nuisance of an overflowing ice-box pan can be eliminated

Another Micrometer of Interesting Design

FEW departments of tool manufacture show so much variation between the work of individual designers as is to be seen when we compare the various micrometers that are to be found on the market today. This tool figures in these columns of interesting inventions about as often as any other, and this month we present it again, in a form which will attract all who are interested in this tool and its applications. The particular assembly illustrated is got up as a cylinder test gage, but of course the same general design could be employed for other purposes. The photograph is one of those rare ones which so completely shows the manner of using the tool and the way in which the tool does its work, that it leaves little or nothing to be said textually.



Micrometrical cylinder-gage of unusual readability

Increases Ice Box Space

WHEN these glass ice box dishes illustrated here are placed one upon the other, as they are designed to be used, they will occupy but half the space.

Each dish has a glass ridge at the top upon which another dish is to rest. Ventilation is provided for by a small cut-out on all four sides.

The glass is the bake-in-the-oven kind.

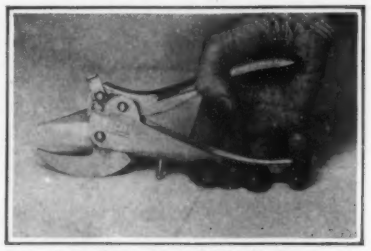
A Pendulum Viscosimeter

EXPERIMENTS have recently been made by E. H. Barton and H. M. Browning (*Phil. Mag.*, March, 1924) with plates affixed to the bottom of pendulums, and so arranged that as the pendulums swung downward the plates dipped into tanks of fluid. The plates were not rigidly joined to the pendulums, but hung loosely from them so that they could be retarded, independently of the pendulums proper, by the resistance of the fluid. The results were sufficiently consistent to show that it would be possible to use this method to construct a viscosimeter (apparatus for measuring viscosity); and that, by suitably varying the size of the plates and their distances from the axis, the apparatus could be made to deal with a wide range of viscosities.

A Substitute for Mufflers on Motors

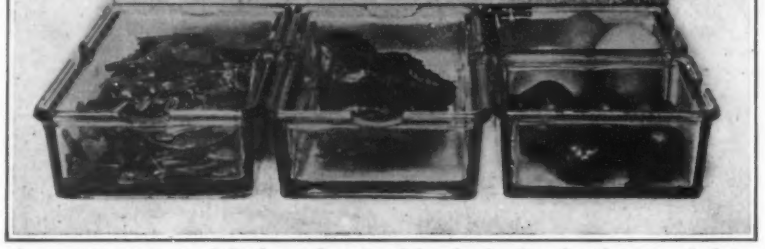
THE California Transit Company has taken off mufflers from their seventy-four motor stages and has thereby eliminated the trouble and expense of keeping this part of the stage in serviceable condition. Substituted for the muffler is a triangular-shaped attachment put on the end of the exhaust pipe which has been found to muffle the sound of motors in an entirely satisfactory manner.

As shown in the photograph the attachment is a sheet metal triangle about 12 inches by 12 inches plan, which changes the cross section of the exhaust line from a circle to a rectangle 12 inches long and one-eighth inch wide. To reinforce the open end of this triangle terminal, three narrow strips are spot welded across the one-eighth inch opening from the upper to the lower part.



Pruning shears in which the leverage principle is employed thus increasing the cutting power

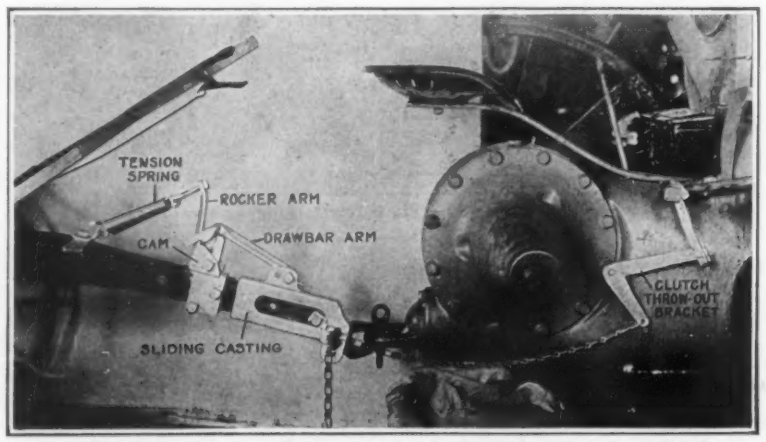
A better combination of tail-light and spot-light



A greater amount of food can be stored in the ice-box by the use of these well-designed glass dishes which are made to fit one on top of the other

This triangular-shaped, sheet-metal attachment put on the end of the exhaust pipe takes the place of the usual muffler

Place this simple device over the spot where a tack is wanted—press down on the knob—and this automatic tacker does the rest



Automatic release that makes the tractor drop the plow when the going is too heavy, and pick it up again when the plow is backed off of the obstruction

Pruning Shears with Greater Cutting Power

IN pruning shears with shorter blades yet stronger cutting power, a new principle is used, the leverage one. The object to be cut is forced to the fulcrum, and not away from it, while the cutting motion is straight up and down.

A guard provides insurance against the blade slipping down when cutting overhead. Blades can be locked for greater safety when carrying the tool in one's pocket.

A Novel Rear-Lighting Assembly

WITH the very general use of "stop-lights" designed to inform the driver behind when the man ahead is going to slow down, turn out, or do anything else different from continued progress in a straight line at uniform velocity, there have been numerous inventors who have turned their thoughts toward the possibility of combining the spot-light with the ordinary tail-light. The distinguishing feature of one of the recent offerings in this direction is its beehive dome of prismatic ruby glass. Both outside and inside this dome the shape is that of carefully calculated prisms that reflect and direct the light, with a minimum waste, providing a strong warning light not only straight behind but far to either side. All this is mounted in a strong holder that includes provision for the license plate. Instead of being soldered, the various lamp-supporting portions of this frame are strongly riveted. The accompanying photograph will indicate the very trim appearance of this assembly.

A Simple Device for Driving Tacks

THE tacker shown on this page is another device that was designed to take the place of clumsy and inefficient tools.

This machine is nearly automatic in its action. All that is necessary to drive a tack is to place the machine over the desired spot and to press down the nickel-plated knob. The tacks, which really are not tacks at all but small staples about one-half inch wide with teeth one-quarter inch long, are carried in a sort of magazine at the bottom of the tacker. This magazine, holding fifty of the "tacks" is kept in place by a coil spring which at the same time pushes the magazine forward as the "tacks" are driven.

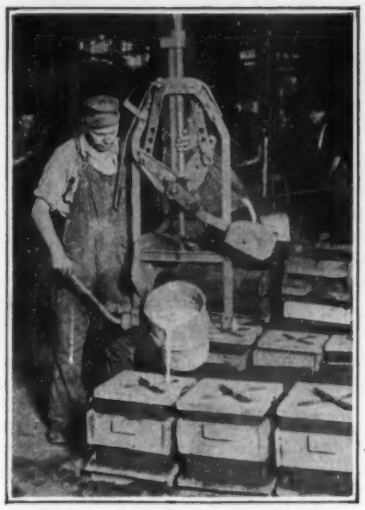
There is nothing complicated about it and a fresh supply of tacks can be inserted in a few seconds time.

Automatic Release and Rehitch for Tractors

A DEVICE for use in stony ground in connection with tractor plowing is being manufactured by a Wisconsin firm. This device is always in connection and is rehitched automatically by backing the tractor in order to disengage the plow from the obstruction.

When the plow meets up with a real obstruction a tension spring is expanded and a rocker arm is permitted to tip slightly. This tipping permits the drawbar on the lifting end to make contact with a cam, when another drawbar arm releases the sliding casting. The sliding casting slips ahead on a beam, following the tractor. A chain connected to a pin in the plow beam is tightened and the throw-out bracket is pulled; and the clutch being released the tractor is stopped instantly.

The clutch hook is lifted off from the clutch lever for reversing. This device does not increase the distance between the tractor and the plow but retains the same spacing in order to keep the plow lever within easy reach of the operator of the tractor.



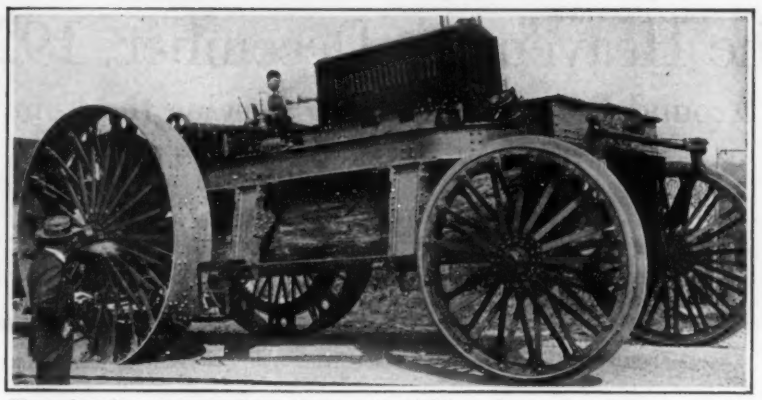
A device which keeps the foundrymen happy

The Crucible Pouring Device

HAVE you ever watched foundrymen pouring crucibles by hand or seen them carrying heavy crucibles of molten metal at a stooped-over dog-trot and pouring the contents painfully into flasks, running back for more, always with back stooped over? They found straightening up took too much time, so they maintained a bent-over position throughout most of the working day and took half an hour at night to work the kinks out of their backs.

The modern crucible pouring device which we illustrate is manufactured in Port Washington, Wis., and was designed to keep the kinks from ever getting into the foundryman's back. Before the introduction of this sort of appliance three, four, and sometimes five men were often required to carry and pour a crucible. Now this labor is eliminated. One man carries the crucible—or rather, pushes it along an overhead trolley which holds it up. Another skims it when necessary.

The overhead system is very simple, a short strip of monorail usually sufficing to transport the pouring device from the furnaces to the pouring cranes. When the crucible is "pulled" from the furnace, it is set into the pouring shank which rests on the floor, and is skimmed. Then it is raised to position and moved about on the trolley for the pouring.



Huge logging tractor of ten tons, net weight, so large that it can straddle a small automobile

A Giant Tractor

WHEN one deals with mechanical giants of the modern age, the tractor illustrated on this page must come in as candidate for very honorable mention. If the scale offered by the presence of two human figures in the picture is not sufficient to give an idea of the size of the machine, perhaps something of vividness will be added by the statement that there is sufficient clearance for a Ford car to run under it, from stem to stern, through the alleyway under the straddle of the tractor. The big machine weighs ten tons without load, and does the work of several teams of horses in the California logging camp for which it was specially built. Its wheelbase is eighteen feet, and the larger wheels have a diameter of ten feet. No statement is made of gasoline consumption or horsepower, but it is obvious that both must be of great magnitude.

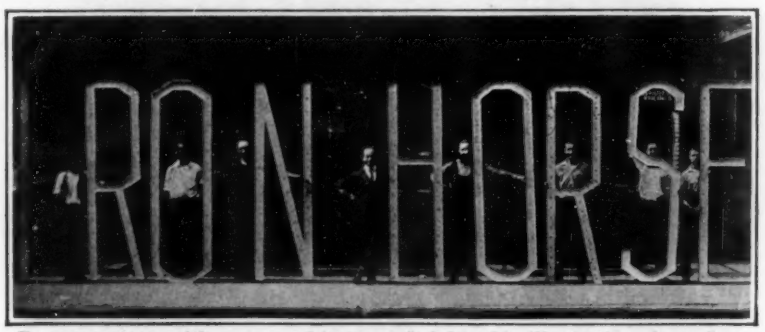
A New and Startling Method of Advertising

EVEN bland Broadway was startled when it stared up beyond the glare of its white lights to see a great electric advertising sign flying along at the rate of seventy miles an hour.

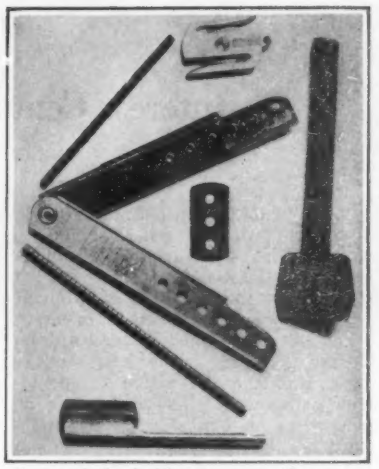
William Fox, New York motion picture producer, was the first advertiser in the world to adopt this novel method of reaching the public. When he was ready to announce his picture, "The Iron Horse," a story of the transcontinental rail builders now playing at the Lyric Theater, he contracted with two airplane concerns to supplement a barrage of newspaper and billboard publicity.

Planes with electric letters beneath the fuselage, announcing "The Iron Horse," were sent out.

A switch control enables the flyer to flash the sign on or off, as he passes over points of dense congestion.



By comparison with a man of average height, this illustration shows how huge the electric letters really are

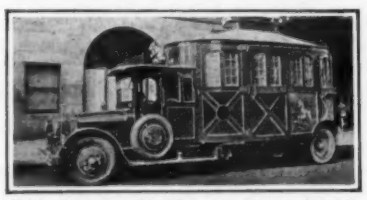


Some of the holders now on the market which permit the miscellaneous use of old safety razor blades

How to Utilize Old Safety-Razor Blades

WHY throw away your old razor blades even if they have been resharpened? There are many uses to which they can be put if the proper holder is utilized.

One holder consists of a pair of brass plates folded together and secured by slotted tubes. Slip an old Gillette type blade over the raised, punched holes and secure it with the tubes. You now have a splendid cutter, scraper, slicer or first-class eraser. As shown here, there are several types of holders, the use of which will make highly efficient tools.

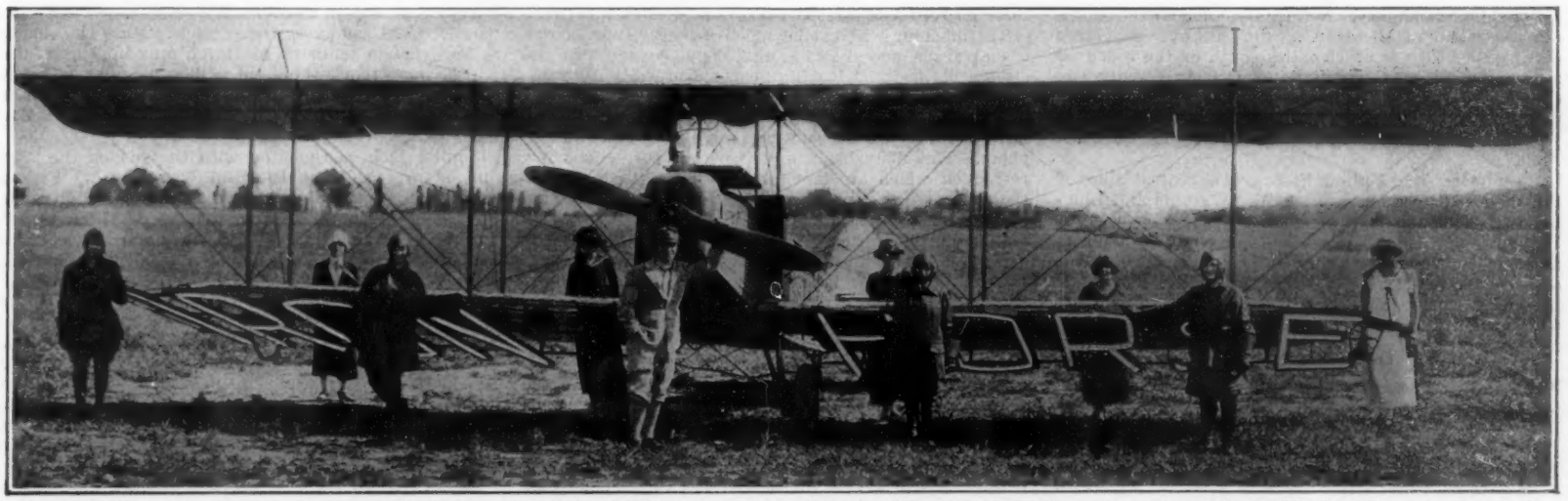


This bizarre looking auto, equipped with everything for his equine majesty's comfort, is used for the transportation of race horses

By the use of this plug a number of headsets can be immediately placed in circuit

"Plug a Plug in a Plug"

AN ingenious radio plug for connecting headsets and loudspeakers to a radio set has been developed by a Pacific Coast radio manufacturer. The use of this plug enables additional headsets to be connected to the radio receiver instantly without the troublesome connecting of separate wires. Although in size no larger than an ordinary plug, this device contains in itself a switch jack so that the mere insertion of one plug in another connects the circuits in series instantly.



The night-flying electric sign is composed of letters ten and a half feet deep, the whole sign being forty-one feet wide. It contains 800 bulbs of twenty-one candle power each, with reflectors and a special dynamo to feed the batteries which are carried in front of the pilot's seat

The Heavens in December, 1924

Interest Centers Around Preparations for Observing the Coming Solar Eclipse

By Professor Henry Norris Russell, Ph.D.

THE attention, not only of astronomers, but of the general public, is centered this winter upon the coming eclipse of the sun. Although it does not happen until next month, there is so much to be said that we may well begin now.

Eclipses are common enough affairs. At least twice in every year the moon passes between the earth and the sun and nearly enough in line to obscure at least some part of the sun's disk for observers situated somewhere on our planet. Although the moon is so much smaller than the earth that she cannot hide the sun, even partially, from the whole face of the earth at once, she does get in the way for any given terrestrial station fifty times or more in a century. Everyone who cares in the least to do so can see a solar eclipse without leaving home or waiting for many years.

But a *total* solar eclipse is a very different matter. To begin with, the moon must be nearer to us than the average, so that she may look bigger than the sun, or, to put it otherwise, so that her shadow, (which tapers to a point at the distance from which the moon would look as big as the sun) will reach up to, or beyond, the earth.

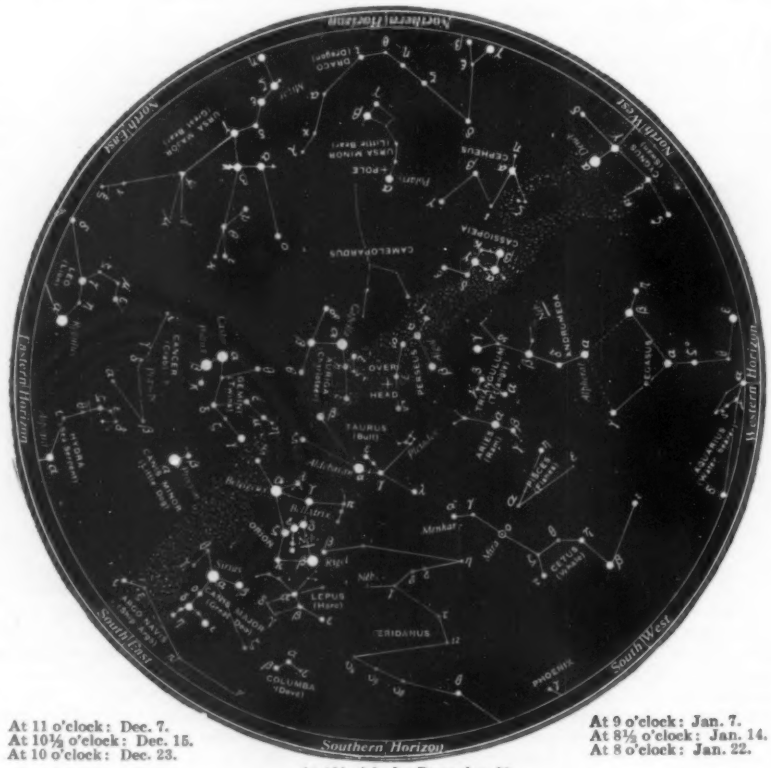
This happens, on the average, rather more than once in two years. But if the point of the shadow barely reaches the earth, it will be so narrow and will pass over so quickly that few observations can be made. Allowing for this, and for cases when the shadow path falls in the polar regions or on the ocean, there remains a total eclipse every three or four years, an eclipse which can be observed if one goes far enough to see it.

But an eclipse where the moon's shadow passes over a densely populated region inhabited by millions of civilized people is decidedly rare, although the intervals between such events are very irregular. The last total eclipse visible in New England, for example, happened on June 24, 1806. After the 24th of next January, however, only seven years need elapse, until on August 31, 1932, another eclipse may be seen. After that, we must wait until 1959, when the eclipse will occur just at sunrise and hardly worth observing.

On the present occasion circumstances are less fortunate than in 1806—when totality happened near noon of a summer's day—but are favorable enough to justify considerable preparation by astronomers and a wide-spread public interest. The path of the shadow is between 100 and 110 miles wide. Reaching the earth first, on the sunrise edge, in Northern Minnesota, it sweeps across the western bay of Lake Superior, just grazing Duluth, and over the region near the Wisconsin-Michigan boundary. Neither here nor on the southern peninsular of Michigan does it pass over any large cities. Bay City is seven miles south of the obscured zone. Port Huron twenty, and Detroit seventy-five. Crossing Lake Huron, the shadow traverses the peninsula of Ontario, Hamilton being very near the central line and Toronto ten miles inside its northern limit.

Re-entering the United States, the central line of the shadow passes close to Buffalo, Watkins and Binghamton, New York, grazes the northeastern corner of Pennsylvania, crosses the Hudson about five miles north of Newburg, goes close to Danbury, Connecticut, and over New Haven in the same state. Thence it passes out to sea across Montauk Point, Long Island. The northern limit of the shadow runs a dozen miles north of Rochester, eight miles south of Syracuse, at an equal distance north of Hudson, two miles south of Springfield, Massachusetts, right over Providence, Rhode Island, and five miles north of New Bedford, Massachusetts. The southern boundary of the shadow passes ten miles south of Dunkirk, New York, five miles south of Olean, five miles north of Wilkes Barre, Pennsylvania, eight miles north of Stroudsburg, Pennsylvania, and right across the middle of New York City, the computed limit bisecting Manhattan Island in the vicinity of Central Park. A map of the eclipse track was published in the SCIENTIFIC AMERICAN for November, 1924, on page 312. Innumerable others will doubtless be published elsewhere.

The duration of the eclipse varies from a minute and forty-two seconds in Michigan to two minutes and three seconds at Montauk Point. This is long enough to permit the scientist to make important observations and the sightseer to look his fill. Every one will be an early riser that morning, for the thrilling moment of mid-eclipse comes at 9:07 A.M., at Buffalo (Eastern Standard time), 9:10 at Binghamton, and 9:14 at Montauk Point. This makes the speed of the shadow almost a mile a second. This is greater than that of the moon in her orbit, for the shadow strikes the earth's surface very obliquely, and its rate of progress over the land is much greater than the rate of its lateral advance in space. All these circumstances are favorable for observation, but the low altitude of the sun, only about 18 degrees in New England and some degrees less farther west, is a serious drawback.



NIGHT SKY: DECEMBER AND JANUARY

The amateur will not be much bothered, indeed the casual gazer may be glad that he does not have to stretch his neck by looking nearly overhead. But the worker with the telescope may be troubled with the bad "seeing" which is encountered when the sun's rays have to follow a long slanting path through the atmosphere. This disturbance and the large corrections for refraction which are inevitable at low altitudes make the present occasion decidedly unfavorable for taking further photographs to investigate the Einstein effect.

But the one serious hindrance, although unspoken, must be already in all our readers' minds. What about the weather in New York and New England on a January morning? Our off-hand guesses might set the odds very much against having anything to see but clouds but the carefully gathered statistics of the Weather Bureau look better. The chances of good weather, although varying from place to place, are nearly even. A 50 percent chance to see so magnificent a spectacle as a total eclipse is well worth taking.

The risk of bad luck with the weather is serious enough, however, to cut down the programs of the astronomers to modest dimensions and cost. The usual photographs of the corona will be made, with instruments of all sizes. Spectroscopic observations, both of the flash-spectrum and of the corona, will be in order.

The form of the corona changes with the sun-spot cycle and no good chance of photographing it at just the present stage—on the sharp rise toward the sun-spot maximum—has yet occurred. Accordingly these photographs will be awaited with much interest. Observations of the spectrum, especially those which show at what heights above its base the sun's atmosphere emits light of different sorts, are still needed, all the more so, in view of the recent noteworthy progress in spectroscopic theory. On the other hand, little will probably be done on the Einstein effect, although some further tests may be attempted. In view of the conclusive character of the results obtained in Australia this is no very serious matter.

Should the weather favor, however, this eclipse should be a great day for the amateur astronomer and for the whole intelligent public. Considering the large population resident in the zone of totality and the ready accessibility of many points within this zone to visitors from outside it, the number of people who watch the progress of the phenomena and who understand their meaning should be great beyond precedent. What such observers may expect to see, how they may best equip themselves and in what ways they can make their gazing of value to science as well as to themselves, we will tell in this department in the next issue.

The Heavens

The winter constellations are now in their full glory. Orion blazes high in the south, with Taurus above and to the right and Canis Major below and on the left. Far down on the horizon to the right of Sirius, observers in the Carolinas and southward may see the brilliant Canopus, next in brightness to Sirius among all the stars. Canis Minor, Gemini and Auriga are in the east, the last almost overhead. The great Bear is coming up in the northeast, while the Little Bear and Dragon are low in the north and Cassiopeia and Cepheus well up in the northwest. Pegasus Andromeda and Aries are in the west, with Perseus nearly overhead. Cetus and Eridanus occupy the dull southwestern sky.

The Planets

Mercury is an evening star for most of this month and is in elongation, nearly 21 degrees from the sun on the 9th. He is so far south that he sets early (5:45 P.M.) but, even so, he may be visible in the twilight. Later in the month he draws rapidly in toward the sun, passes through conjunction on the 26th, and is invisible.

Venus is still a morning star, rising between 4:30 and 5:00 A.M., and very conspicuous. Mars has shrunk to less than a tenth of his brightness in August and will be more than a hundred million miles away before the year closes, but he is still conspicuous. On Christmas Day he is in quadrature, east of the sun, and is due south at 6:00 P.M.

Jupiter is in conjunction with the sun on the 23rd, and is practically invisible all the month. Saturn, which passed conjunction in October, is a morning star, and rises before 4:00 A.M. for most of the month. Uranus is in quadrature on the 9th, and is observable in the evening, while Neptune crosses the meridian about 4 A.M., and can be studied in the morning.

The moon is in her first quarter at 4:00 A.M. on the 2nd, full at 2:00 A.M. on the 11th, in her last quarter at 5:00 A.M. on the 19th, and new at 11:00 P.M. on the 25th. She is nearest us on the 25th, and farthest away on the 12th. During the month she comes into conjunction with Uranus on the 3rd, Mars later on the same day, Neptune on the 16th, Saturn on the 22nd, Venus on the 23rd, Jupiter and Mercury on the 25th, and Uranus again on the 30th.

At 10 P.M. on the 21st the sun reaches his greatest southern declination, and, in almanac parlance, "Winter commences."

Recently Patented Inventions

As a convenience to our readers, we will supply copies of any patents listed herein for 15 cents each. The official printed copies of patents include complete descriptions and drawings of the inventions disclosed. State the patent number to insure receipt of the desired patent copy.

Pertaining to Aeronautics

MOTORLESS AERIAL WINGED TORPEDO—That may be dropped from aircraft upon targets that are out of their vertical line, even at a great distance. Patent 1508317. G. A. Crocco and A. Guidoni, c/o L. Laboccetta, Via Due Macelli 31, Rome, Italy.

Electrical Devices

LIGHTING FIXTURE—Which is portable, and may be supported upon a table, or suspended from a ceiling or wall. Patent 1505,-778. A. Hansen, c/o Dominion Hotel, Globe, Arizona.

MOP—Actuated by the usual electrical current installed in a dwelling, adapted for both washing and mopping floors. Patent 1505,-786. J. M. and J. C. Kaiser, 1216 19th St., Rock Island, Ill.

QUICK-ACTING AMPLIFYING BREAK KEY FOR WIRELESS TELEGRAPHY—For handling messages at high speed, and also eliminating the "send to receive" transmitter switch. Patent 1506580. H. E. Hallborg and H. R. Miller, 24 Macohin Ave., Upper Montclair, N. J.

SPOTLIGHT DEFLECTOR—Arranged to deflect part of the light at any desired angle without shutting off the usual spot. Patent 1506727. F. P. Rampp, 3993 Carpenter Ave., Bronx, N. Y.

WATER HEATER—In which the temperature of water is automatically maintained, through the medium of an electric heater. Patent 1506676. J. Shahan, Gadsden, Ala.

SHOE-CLEANING DEVICE — Electrically driven, by any ordinary source of current, designed for household use. Patent 1506696. R. Walser, 122 Franklin St., Union Hill, N. J.

FUSE—Of the magazine type which can be quickly reloaded without the use of any tools. Patent 1507194. W. A. Miller, R. F. D. No. 2, Beaver, Pa.

INCANDESCENT LAMP—In which the filament is supported in a straight line coincident with the longitudinal axis of the lamp. Patent 1508302. C. C. Schnur, 35 Dundonald St., Toronto, Canada.

DISTRIBUTOR—Easily attached to timers, and designed to make the traveling roller less susceptible to vibrations than the ordinary assemblage. Patent 1508060. E. J. Lee, c/o Never Break Products Co., Bangor, Pa.

ELECTRIC MOTOR GENERATOR—Embodying special bearing means for the armature shaft, which greatly enhance the efficiency of the machine. Patent 1508096. W. R. Garner, Erie, Pa.

Of General Interest

TABLE—Of the extension type, which is strong and readily adjustable to vary the size, as desired. Patent 1503195. C. O. Lowe, Shawmut, Mont.

WALL SHEATHING—Providing a simple means for insulating a wall and securely holding plaster or stucco in position. Patent 1501476. C. O. Cowan, Box 343, Palo Alto, Cal.

SUIT BOX—Such as are used by tailors and clothiers, which may be readily carried without wrapping or tying. Patent 1501134. C. E. Osburn, c/o Thuenen & Thuenen, Davenport Savings Bank, Davenport, Iowa.

FOCUSING VIEW FINDER—Adapted for hand cameras, manipulated with the camera lens, and in focus on the finder when the larger lens is focused on the film. Patent 1501295. W. E. Wilson, Box 173, Mount Rainier, Md.

INSULATED CONTAINER—For receiving ice cream and maintaining it in a frozen condition without ice or salt during shipment. Patent 1501227. L. F. Marsh, Gardiner, Mont.

CLIP—For associating sheets, cards, or other articles, and associating with the articles indicia bearing means. Patent 1504,-141. N. Ritter, 2326 83d St., Brooklyn, N. Y.

HUMIDIFIER—Especially designed for use in conjunction with the common forms of pocket size tobacco tins. Patent 1504062. A. C. Ladd, Box 632, El Paso, Texas.

PERFORATING DEVICE—Adapted for marking checks and drafts so that their commercial value cannot be altered. Patent 1504181. K. H. Borland, Cape Vincent, N. Y.

WINDOW SHADE—With adjuster that suspends the shade so that it hangs freely, constraining its movement under the influence of the wind. Patent 1503700. T. J. Moore, Longview, Texas.

FOLDING BABY CARRIAGE—Having the appearance of a suit-case when folded, and having available space for carrying clothes, etc. Patent 1503714. N. Schnipper and R. Brody, 225 E. 119th St., New York, N. Y.

TRAP—For catching rats and other vermin, the trap is easily baited and automatically resets itself. Patent 1503480. A. B. Cobbs, Crotherville, Ind.

HINGE FOR VANITY CASES—By means of which two covers may be secured by the same hinge member. Patent 1503367. W. G. Kendall, 118 Market St., Newark, N. J.

WREATH—Formed of sections to simulate foliage, the sections when connected giving a natural appearance. Patent 1504571. B. H. Marshall, 1745 12th St., Detroit, Mich.

SIGN HOLDER—Easily set up to hold sign plates and readily disconnected when the sign is to be packed for shipment. Patent 1505046. C. H. Lush, c/o Beacon Mfg. and Sales Co., East Merrick Rd., Freeport, N. Y.

TRACE CARRIER—Which makes it possible to easily unhook a trace, at the same time prevents accidental uncoupling. Patent 1504560. F. C. Krause, Mansfield, S. D.

HONING AND STROPPING DEVICE — By means of which safety razor blades may be successively honed and stropped or stropped only without removal from the device. Patent 1504814. E. L. Crespo, Guatemala City, Guatemala.

PAPER HANGERS STAIR TRESTLE—Whereby the table of a paper hanger may be set up in halls or other comparatively small places. Patent 1504971. P. J. Pollnick, 842 Bushwick Ave., Brooklyn, N. Y.

ADVERTISING DEVICE — Adapted to be readily attached to or detached from the spare tire of a vehicle. Patent 1504907. E. Sandusky, 1315 Olive St., Los Angeles, Cal.

HAND BAG—With means for holding the bag in a given shape, but permitting collapsing the bag at any time. Patent 1505,-012. G. Distefano, 7500 18th Ave., Brooklyn, N. Y.

RECEPTACLE—Having a plurality of compartments constructed from a folded-up unitary blank of sheet material. Patent 1505,-045. C. Lohrman, Wantagh, L. I., N. Y.

COMBINED FASTENER AND ATTACHING DEVICE—Which forms a loss-preventing and fastening means for pins, badges, and the like. Patent 1504398. A. L. Thornton, Box 559, El Paso, Texas.

FILM OR PLATE HOLDER—Composed of telescopic sections thereby eliminating slides, doors, curtains and springs commonly employed in photographic plate holders. Patent 1505000. E. E. Whiting, 1841 Central Ave., Minneapolis, Minn.

SMOKING PIPE—With means for segregating the saliva, and cooling the smoke. Patent 1503629. A. G. Blomster, Amidon, N. D.

PUNCH—Designed for perforating paper sheets for accurately fitting loose leaf binders. Patent 1505775. G. P. Gail, 1503 Munsey Bldg., Baltimore, Md.

BURGLAR ALARM—Adapted to act upon shifting the position of either the upper or lower sash of a window. Patent 1505760. A. P. Abbott, Dexter, Me.

WATER CLOSET—In which the bowl may be flushed without the use of the ordinary valve. Patent 1505799. J. J. Parkinson, 3810 No. Clark St., Chicago, Ill.

CRATE—Which may be collapsed for storage and is adapted for the shipment of bananas. Patent 1506627. E. A. Francis and W. Salow, Marshalltown, Iowa.

MEANS FOR MAKING CASTS—By means of which a cast may be readily made of the foot, preparatory to fitting a shoe. Patent 1504822. E. Hess, Room 802, 216 W. Water St., Milwaukee, Wis.

GRAVE MARKER—For the identification of the deceased, the device is durable and unchanged by the elements. Patent 1504565. J. M. McNeill, 1015 Main St., St. Joseph, Mo.

COMBINED MATCH HOLDER AND CIGARETTE CONTAINER—Adapted for embodiment in the conventional form of cigarette packets. Patent 1505133. W. R. Derry, Box 593, Augusta, Ga.

DRESSING CHAIR—Wherein means are provided for the holding of wearing apparel, and supporting the feet to lace or polish shoes. Patent 1505829. H. W. Warnecke, 1293 Rodman Place, Bronx, N. Y.

TRENCH WARFARE DEVICE—Providing a portable housing adapted to elevate a gunner and machine gun above a trench. Patent 1505168. C. E. Sparhawk, Drumbeller, Alberta, Canada.

POULTRY SPRAYING APPARATUS—Which will automatically spray the poultry during their entrance or exit to the poultry house. Patent 1505641. E. D. Hendrickson, 1512 W. 64th St., Seattle, Wash.

DEVICE FOR DRAWING PARALLEL LINES—With means for keeping an equal distance between the lines to be drawn. Patent 1505,-873. G. D'Eramo, Via Galilei 27, Rome, Italy.

CARBOY—Having novel cushion members disposed at the corners and the bottom. Patent 1505789. C. Lefkowitz, c/o National Box & Lumber Co., 350 South St., Newark, N. J.

CARBOY BONNET—For protecting the neck of the bottle, of durable construction and readily fastened to the carboy. Patent 1505,-790. C. Lefkowitz, c/o National Box & Lumber Co., 350 South St., Newark, N. J.

DESK ATTACHMENT—Including a desk cover which may be readily kept clean, and a receptacle for clay as used in schools. Patent 1505803. N. O. Pylick, 1877 E. 75th St., Cleveland, Ohio.

REMOVABLE LINING FOR CLOSETS — Designed to be readily placed within a closet to protect garments against insects, such as moths. Patent 1506566. W. R. Coffee, 2179 Grand St., Maspeth, L. I., N. Y.

SOUND-REPRODUCING DEVICE—Adapted to either a vertically or laterally cut record, a tone arm and horn being dispensed with. Patent 1506562. L. R. Button, Kittanning, Pa.

IRON-REINFORCED SHOE HEEL—The edge of which is fitted with a rim of nails reinforcing the heel and preventing slipping. Patent 1506693. A. C. Tirapani, 21 Via Farini, Bologna, Italy.

TWIN-COMPACT VANITY CASE—Designed to house rouge and powder compacts and expose both simultaneously for use. Patent 1506589. S. A. Jaroslawski-Fioret, 677 5th Ave., New York, N. Y.

BABY RATTLE—Whereby in the ordinary playing of the baby, the rattle will produce designated sounds. Patent 1506567. I. E. Cohn, c/o Irwin & Co., 65 4th Ave., New York, N. Y.

PIPE REAMER—Designed especially for cleaning the bowls of tobacco pipes without injury. Patent 1506465. D. M. J. Wall, 609 W. 114th St., New York, N. Y.

COSMETIC HOLDER—For holding lip and similar cosmetic sticks permitting the intermittent use of the same. Patent 1506590. S. A. Jaroslawski-Fioret, 677 5th Ave., New York, N. Y.

WEATHER STRIP GUIDE—Whereby a window sash or like closure may be mounted to slide easily, and protected against the action of the elements. Patent 1507224. D. W. Arave, Lava Hot Springs, Idaho.

TOOTHBRUSH HOLDER AND STERILIZER—In which the brushes may be kept in an accessible and sanitary condition. Patent 1507466. W. H. Collins, 18 Jay St., New York, N. Y.

OIL CAN—By means of which the oil can be forced therefrom irrespective of the position of the can. Patent 1507498. W. C. Matthews, 325 73d St., Brooklyn, N. Y.

COLANDER—With means for firmly supporting the same on containers of different sizes or above flat surfaces. Patent 1507522. Rose C. Simon, 562 W. 164th St., New York, N. Y.

WINDOW CONSTRUCTION—In which the movable sash is prevented from any lateral play, thus obviating rattle. Patent 1507119. C. A. Karpenstein, 2100 Warren Ave., Chicago, Ill.

SHIPPING CASE—Of the collapsible type, which may be readily knocked down when not in use. Patent 1508266. C. E. Barrie, 211 Barber Bldg., Brattleboro, Vt.

TASSEL—Formed from silk strands and adapted for ornaments or personal wear. Patent 1508300. A. Sacks, c/o Novelty Cord & Tassel Co., 460 Rodney St., Brooklyn, N. Y.

MEANS FOR SUPPORTING VACUUM-JACKETED BOTTLES OR OTHER RECEPTACLES WITHIN INCLOSING CASINGS THEREOF—By spring members adapted to support the bottom part of the bottle both laterally and from below. Patent 1508309. E. Urbahn, c/o F. Schwenterley, Koniggratzerst 59, Berlin S. W. 11, Germany.

Hardware and Tools

SAW SET—By means of which the teeth of a cross-cut saw can be quickly and easily set. Patent 1505260. C. A. Hanson, Wauna, Oregon.

COMBINATION LOCK—Which may be easily opened in the darkness, the combination being indicated by distinct clicks produced by the mechanism. Patent 1505164. E. P. Rambaud, 3205 St. Ann St., New Orleans, La.

FOLDING CAN OPENER—Provided with a guard for the cutting blade so that it may be carried in the pocket. Patent 1507093. K. F. Schionger, 3925 W. North Ave., Chicago, Ill.

EXTENSION BOLT—For use in conjunction with the slotted tables of machines, for clamping articles of different sizes. Patent 1507488. E. E. Kraemer, Box 139, Hicksville, L. I., N. Y.

PADLOCK—Easily manipulated for opening or closing, but resisting great opening force when locked. Patent 1507213. J. Singer and P. Rekettye, c/o J. Singer, Berth 90, San Pedro, Cal.

HOSE CLAMP—Adapted for securing hose to a coupling or pipe, the clamp being formed of a single length of wire. Patent 1507170. F. W. Gunn, 107 Clifton St., Boston, Mass.

ICE TONGS—In which the shank terminals are connected by a flexible handle member. Patent 1508340. C. J. Kroening, 2407 Main St., Evansville, Ind.

SAFETY HOOK — Having swivel devices connected thereto, and means for preventing accidental disconnection. Patent 1508308. F. C. Thompson, 215 Edwards St., Shreveport, La.

Heating and Lighting

VAPOR OIL BURNER — Having control means giving uniform results at both high and low flame. Patent 1505848. J. Bartel, R. 8, Hillsboro, Kans.

FURNACE—Providing an attachment to the door, whereby heated air may be admitted to the fire box. Patent 1507469. J. M. Corson, 362 86th St., Brooklyn, N. Y.

OIL BURNER—With means for mixing oil and air and igniting the same to form a flame for a cooking stove. Patent 1507484. F. Humphreville, Chester Inn, Atlantic City, N. J.

CAMP STOVE—Of small and compact form, employing alcohol or like fuel, and under all conditions efficient. Patent 1508334. W. R. Ingalls, 52 Dennett St., Portland, Maine.

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Machines and Mechanical Devices

PROCESS OF MINING SOFT ORE—A greater part of the ore being conveyed by gravity from one sub-level to the next, saving manual handling. Patent 1502030. S. J. Goodney, Box 436, Crystal Falls, Mich.

WIND MOTOR—Having novel means for keeping the speed of the wind wheel constant no matter at what velocity the wind is moving. Patent 1502950. H. C. Greebrook, 1636 N. Francisco Ave., Chicago, Ill.

IMPELLER FOR ROCK CRUSHERS—Formed with cushioning members or rubber such as is used in tires for motor vehicles. Patent 1499455. A. D. Hadsel, 500 Call Bldg., San Francisco, Cal.

ICE-CREAM-OVERRUN TESTER—In which a direct reading in per cent of overrun of ice cream mix is given. Patent 1502967. H. H. Sommer, 116 S. Warren St., Madison, Wis.

STAMP-AFFIXING DEVICE—For holding a plurality of postage stamps and affixing a single stamp to mail matter on each operation of the device. Patent 1503389. M. A. Taylor, Box 662, Oreade Sta., Los Angeles, Cal.

CLASSIFYING APPARATUS—For use with ore, automatically operating to discharge the solid matter. Patent 1501204. F. De Mier, 201 Vantage St., Picher, Okla.

BAILER—Adapted for withdrawing mud and sludge from wells and saving the oil. Patent 1501306. A. Boynton, 1019 City Natl. Bank Bldg., San Antonio, Texas.

APPARATUS FOR POLISHING GRAIN—Wherein the mass of rice undergoing the polishing operation is maintained at a uniform temperature. Patent 1501610. H. T. McGill, Stuttgart, Ark.

FOLDING MACHINE—Which folds paper napkins or the like, without their being handled. Patent 1501774. F. W. and T. E. Heeter, 1402 Detroit Ave., Toledo, Ohio.

CLOTHES POUNDER—For forcing air and water through the article to be washed. Patent 1503395. C. J. Vasgreen, Box 113, Mogollen, N. M.

ROTARY PUMP—Having an assemblage of a ring gear and an eccentric pumping pinion passing the pumped fluid through the openings in the ring gear. Patent 1503362. H. H. Haight, 204 Grand Ave., Milwaukee, Wis.

FLOWING DEVICE FOR WELLS—Adapted to utilize the pressure within a well for the purpose of causing outflow in lieu of the usual pumping. Patent 1501536. L. Friedman and D. Wallace, 336 Kennedy Bldg., Muncie, Ind.

ROTARY DRIER—Including rotating drying shells, a stationary feed head, and seating means between them. Patent 1503054. W. J. Kuntz, c/o McGann Mfg. Co., York, Pa.

MEAT-CHOPPING MACHINE—In which the feed screw is maintained in yielding relation to the perforated dish, keeping the knife from becoming dull. Patent 1504067. J. F. Matthies, 365 East 153d St., New York, N. Y.

HEMP STRIPPING MACHINE—Which may be readily transported, and whereby the manual operation of stripping hemp may be avoided. Patent 1503788. P. H. Frank, 808 Georgia, Manila, P. I.

WELL STOPPER—Firmly engaging the well or casing of the well at any desired point. Patent 1503693. G. H. McLean, Apt. 652, Tampico, Mexico.

HAIR CLIPPER—Power driven, and having an oscillating arm for actuating the cutter. Patent 1503708. J. W. Price, 825 So. Xanthius Ave., Tulsa, Okla.

PACKING BOX FOR OIL WELLS—Establishing a liquid tight connection between the casing head and the sucker rod. Patent 1503782. J. Barnes, Box 631, Burkburnett, Texas.

ROTARY BAKING MACHINE — In which tubular articles of pastry are baked of varying thickness as the dough is applied to a shaper. Patent 1505001. C. Wimson, c/o Bergen Clock Co., 69 Barclay St., New York, N. Y.

DUST REMOVER FOR STONE-DRESSING MACHINERY—Confining the dust to a certain area and automatically removing it to a distant point. Patent 1504994. E. M. Tobin and E. M. White, 23 Academy St., Barre, Vt.

PISTON RING—Which prevents leakage of oil and gas, and in which the connecting ends will not become misplaced. Patent 1505035. S. J. Lamora, 12 Caledonia St., St. Johnsbury, Vt.

PISTON RING—Wherein an oil seal is provided preventing ingress of oil into a combustion chamber. Patent 1504418. M. D. Bell, 3037 W. Kirby Ave., Detroit, Mich.

WIND ENGINE—Forming a kind of rotary tower with vanes for receiving the action of the wind. Patent 1505866. L. J. Costes, 86 Avenue Daumesnil, Paris, France.

DRYING MACHINE—In the form of a heated drum, for drying photographic prints. Patent 1504991. J. Stern, 550 W. 41st St., New York, N. Y.

DREDGE BUCKET—Operable by fluid pressure, to effect the opening, the ejection of contents, and the cleaning of the inner walls. Patent 1504471. A. E. Grau, 2518 Canal St., New Orleans, La.

VALVE-ACTUATING MECHANISM — Which will eliminate both the usual noise, and wear on the moving contact portions. Patent 1504496. M. Peck, 1115 So. 4th St., Saginaw, Mich.

TURBINE PUMP—Including means to draw the oil out of a well and exclude water and sand from the bearings. Patent 1504658. J. A. Ulmer, c/o Ulmer Machinery Co., Porterville, Cal.

LIQUID LEVEL INDICATOR—By means of which the level of liquids in ponds, tanks or other structures may be ascertained without the use of a float. Patent 1504978. T. W. Robbins, 732 W. Granite St., Butte, Mont.

ROPE FASTENER—For use in connection with riggings of ships, guy ropes of tents, in lieu of the usual form of cleat. Patent 1503567. L. E. Wallis and L. Higgins, Monrovia, Cal.

PAVEMENT MARKING MACHINE—Which may be easily used on city streets to establish safety zones or the like. Patent 1503,556. J. O. Rhien, 133½ Garfield St., Santa Cruz, Cal.

RATCHET DRIVE MECHANISM—By means of which a belt or scroll may be wound from one roller to another or reverse. Patent 1504237. J. F. Halverson, 1811 Helena St., Madison, Wis.

COAL-DISTILLING APPARATUS — Which treats the coal with a gas to separate the volatile matter therefrom, and later removes the volatile matter from the gas. Patent 1505057. W. F. Nagel, c/o Gulf States Chemical & Refining Co., Montgomery, Ala.

TABLET-MAKING MACHINE—Designed to receive material in a paste form and automatically discharge the same in tablets. Patent 1505827. E. and A. Villasenor, Merida, Mexico.

APPARATUS FOR SEPARATING LIQUIDS OF DIFFERENT SPECIFIC GRAVITIES AND INDICATING MEANS THEREFOR—Which can be installed on vessels for the automatic separation of oil and water, that the water may be pumped overboard. Patent 1505791. C. S. Lenz and G. E. Jupp, American Marine Device Corp., 400 W. 23d St., New York, N. Y.

PROPULSION SYSTEM—Capable of use with ships or vessels of any kind, and arranged at the bow. Patent 1505832. G. R. Weisz, 684 Lincoln Place, Brooklyn, N. Y.

GRIPPING DEVICE—For gripping objects that may have dropped into a deep well. Patent 1505648. C. P. Skinner, Ventura, Cal.

WRENCH POLE—In the nature of a steel I-beam to which a balance weight is slidably connected, for use in drilling wells. Patent 1505504. L. J. Stoner, 1329 So. Elwood Ave., Tulsa, Okla.

APPARATUS FOR CONDENSING AND FRACTIONATING HYDROCARBONS—And effecting a more perfect separation of the hydrocarbons which are evolved as a body of mixed vapors from a still. Patent 1505798. E. Owen, 1268 83d St., Brooklyn, N. Y.

DRAW FRAME — Which distributes the drawing of the fibers between the rollers and prevents excessive strain and breakage. Patent 1506554. E. Basso, c/o Barzano & Zanardo, 9 Via Due Macelli, Rome, Italy.

VALVE HOLDING DEVICE — Wherein the valve seats are held in place by clamping means extending to an exterior point. Patent 1507448. R. H. Aldrich, Allentown, Pa.

VENDING MACHINE—Adapted more particularly for dispensing pencils, cigars and objects of a like nature. Patent 1507999. H. Hubbard, Dill, Okla.

SAND PUMP—Having simple mechanism for permitting sand and shale in the oil, to settle into a receiver. Patent 1507989. H. H. Defenbaugh, Box 157, Copan, Okla.

(*Continued on page 414*)

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Machines and Mechanical Devices

(*Continued from page 412*)

AIR COMPRESSOR—With the piston rods of the engine cylinders located at opposite sides of the plunger rod of the pump cylinder and connected to the same crank pin. Patent 1506674. C. B. Segner, c/o Domestic Engine & Pump Co., Shippenburg, Pa.

APPARATUS FOR EXTRACTING MILK FROM COCONUTS—Which will puncture the husk, shell and meat to provide a drain for the milk. Patent 1506571. E. Deremberg, Chickasaw, Mobile, Ala.

DISPENSING DEVICE FOR COLLAPSIBLE CONTAINERS—Operating to discharge a uniform quantity of the contents thus eliminating waste. Patent 1507464. J. H. Clegg, 192 Orange Ave., Suffern, N. J.

SIGNALING MEANS FOR TOY BANKS AND OTHER PURPOSES—Which will set in action mechanism for indicating that a coin has been deposited. Patent 1507279. L. Giclas, 1026 6th St., N. W., Washington, D. C.

MARKING MACHINE—Employed in marking ground for irrigation purposes having means for adjusting the shoes to regulate the depth of cutting. Patent 1508329. T. Horton, Challis, Idaho.

TUMBLING BARREL—For the purpose of cleaning, polishing and finishing articles, with means for renewing the lining when worn. Patent 1508345. J. Lupo, Jr., 3636 Park Ave., New York, N. Y.

WASHING MACHINE—Provided with special facilities for conveniently placing the articles in, or removing them from, the cylinder. Patent 1507589. G. L. Ferris, Wellston, Ohio.

HEMSTITCHING AND PICOTING ATTACHMENT FOR SEWING MACHINES—Which may be readily clamped to and rigidly held in place on the machine. Patent 1508000. C. D. Kennedy, Box 1008, Corpus Christi, Texas.

TESTING AND TRUING DEVICE—For testing and straightening the piston rods and pistons of engines. Patent 1507633. J. C. Taylor, Box 2, Hermanville, Mich.

AUTOMATIC DISPLAY-MERCHANDISE SHOW CASE—Capable of supporting vertically a number of garments, which may be projected upwardly into view. Patent 1506086. E. G. Ruby, c/o Ruby's Ladies Store, Bethany, Mo.

AUTOMATIC TICKET AND CHANGE-RETURNING MACHINE—Especially adapted to be used in moving picture theaters and like places, and arranged to sell tickets of different values. Patent 1506250. L. B. Nordlund, c/o Terminal Hotel, 60 Market St., San Francisco, Cal.

Medical Device

DENTAL DEVICE—Whereby artificial teeth may be mounted with respect to a line parallel to the line of vision of the user. Patent 1505792. L. O. Ludlum, St. Louis, Mich.

NOSE WASHER—A simple and easily operable device for washing the nasal passages. Patent 1507475. E. Flagg, 111 E. 40th St., New York, N. Y.

METHOD AND APPARATUS FOR MAKING DENTAL CROWNS—Whereby an exact crown of metal can be easily made of a tooth of any configuration. Patent 1507476. J. M. Flanigan, c/o J. A. Welsh, Shamokin, Pa.

Prime Movers and Their Accessories

SPARK PLUG—Constructed to virtually preclude any danger of fouling or sooting. Patent 1506559. A. Bourcheix, c/o Max Davidson, 53 Winfield Ave., Mt. Vernon, N. Y.

SPARK PLUG—A practical poly-electrode plug with absolute provision against short circuiting. Patent 1505817. C. S. Swanson, c/o Chas. H. Sampson, 12 Cleftstone Rd., Bar Harbor, Me.

EXPLOSIVE MOTOR—So constructed that the piston rests on top dead center until the crank passes top center approximately 25 degrees. Patent 1505856. H. Briggs, 244 Walter St., Hasbrouck Heights, N. J.

IGNITION DEVICE—Employing two concentrically disposed materials affording a relatively high combined value for the product of their respective coefficients of specific gravity and specific heat. Patent 1505762. J. H. Barnard, c/o Engineers Club, 32 W. 40th St., New York, N. Y.

OILING SYSTEM FOR INTERNAL-COMBUSTION ENGINES—For use with known types of motors without materially departing from the designs thereof. Patent 1506553. J. G. Baldwin, P. O. Box 1635, Asheville, N. C.

MIXING VALVE—Whereby the admission of air and fuel to an engine can be easily controlled. Patent 1507533. B. F. Walker and W. J. Harper, c/o F. Gilmore, Route 2, Baxter Springs, Kan.

INTERNAL-COMBUSTION ENGINE—Having a charge-forming device which provides for automatic dilution of the charge at high engine speeds. Patent 1507842. A. A. Loetscher, Box 523, Los Angeles, Cal.

ROTARY ENGINE—Which may be driven by steam, compressed air, or water, the blades being retracted within the body when not in use. Patent 1505788. J. A. Larson and E. Johnson, c/o E. Johnson, 11329 Yale Ave., Chicago, Ill.

Pertaining to Recreation

AMUSEMENT APPARATUS—A competitive game device adapted for amusement parks, comprising a plurality of inflated targets which when properly struck will burst. Patent 1507505. O. D. Munn, Southampton, N. Y.

SCOOTER—With pedal-operated drive means and a brake for the steering wheel. Patent 1507541. H. O. Wilson, c/o Percy W. Greene, 610 Equitable Bldg., Wilmington, Del.

TOY WALKER—Whereby a child can manipulate the device to travel readily while seated. Patent 1507512. J. Perrett, 318 E. 57th St., New York, N. Y.

EXERCISING APPARATUS—Designed to induce muscular action to the abdomen, legs, shoulders, neck and back, and improving physical condition. Patent 1507554. J. J. Cooper, 56 W. 47th St., New York, N. Y.

AMUSEMENT DEVICE—Providing a pleasure railway in which the element of competition enters into the vehicle's operation. Patent 1508319. R. M. Harris, Fanwood, N. J.

Pertaining to Vehicles

AUTOMATIC CLUTCH RELEASE DEVICE—Which functions as the result of the "rearing" of a tractor, preventing the accidental turning over of the vehicle. Patent 1503,682. F. Y. Boyrie, c/o N. Irving, Atty., Hilo, Territory of Hawaii.

BUMPER—Of the air cushion type having brake rod connections for actuating the vehicle brakes under sufficient shock. Patent 1504505. C. C. Reed and H. W. Watson, c/o Reed & Duecker, 171 No. Main St., Memphis, Tenn.

ACCELERATOR CONTROL—Adapted to be applied to Ford cars, and operated either by foot pedal or hand lever. Patent 1504466. J. J. Elster, Doyon, N. D.

BRAKE—That is particularly adapted to be used when the vehicle is coasting down a grade. Patent 1503561. C. P. Ruggles, c/o Am. Hotel, 718 Howard St., San Francisco, Cal.

HINGED CAP—Designed to be used on the gasoline tank of a motor vehicle, so that the cap may not be lost. Patent 1502996. N. B. Loetscher, 727 Bedford Drive, Beverly Hills, Cal.

VAPORIZER—Adapted to be used in connection with steam-driven automobiles or other vehicles. Patent 1503642. A. F. Dayton, 4800 W. Adams St., Chicago, Ill.

EMERGENCY CHAIN FOR NONSKID TIRE CHAINS—To take the place of a broken transverse chain, and may be quickly secured. Patent 1504416. J. R. Baude, 1304 Cornell St., Chicago, Ill.

PNEUMATIC BUMPER—Composed of a plurality of bumper bars having a high degree of resiliency. Patent 1504828. W. G. Moore and J. E. Wood, 301 W. Grand Ave., Chicago, Ill.

DEVICE FOR WASHING VEHICLES—In which a stream of water is forced by air from a nozzle at high velocity. Patent 1504,851. J. J. Wren, 53 N. Washtenow Ave., Chicago, Ill.

TIRE GRIP—For facilitating the movement of an automobile without the help of the engine. Patent 1503725. F. L. Taylor, 2609 Dean Ave., Spokane, Wash.

WHEEL—Having means for releasably securing the demountable rim on the felly. Patent 1505465. H. M. Howell, Monroe, La.

AUTOMOBILE SIGNAL—In the form of a direction signal for indicating the direction of turn of the vehicle. Patent 1505793. R. Lyons, 100 Clifton Ave., Rosebank, S. I., N. Y.

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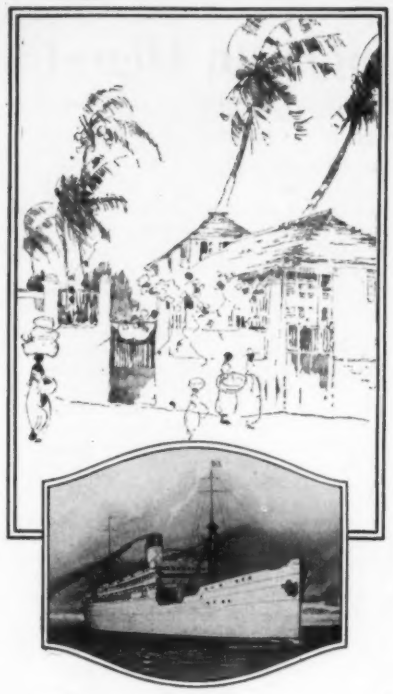

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TRANSMISSION—Which allows the speed of the vehicle to be changed without disengaging the clutch commonly provided. Patent 1504684. J. G. Gallagher, Reno, Nevada.

WAGON AND TRUCK DUMP—Mounted on a weighing scale, whereby the wagon is automatically weighed and locked in position, when dumped. Patent 1505777. W. G. Hancock and L. T. Stromswold, c/o Magic Grain Dump Co., Minot, N. D.

WINDLASS ATTACHMENT FOR AUTOMOBILE WHEELS—Affording means for making use of the power of the driving wheel to extricate the vehicle from obstructions. Patent 1505230. J. F. Taylor, c/o Boyle Hardware Co., Charleston, S. C.

LUBRICATING DEVICE—By means of which the bearings of a vehicle wheel may be thoroughly lubricated without dismounting from the axle. Patent 1505776. G. H. Glade, Jr., 1124 Republic Bldg., Chicago, Ill.

LIFTING DEVICE—Which may be used in conjunction with any conventional jack, to lift the wheels of a motor car. Patent 1505,443. H. A. Stone, c/o Geo. D. Anderson, Keith Bldg., Beaumont, Texas.

AIR CHUCK—That may be set for any desired pressure, and give a warning when such pressure has been reached. Patent 1505491. J. W. Price, Box 1374, Tulsa, Okla.

ATTACHING LINK FOR TIRE CHAINS—For connecting cross chains to the circumferential chains, easily applied when the skid chain is on the wheel. Patent 1505440. C. Smith, c/o Y. M. C. A., Calumet, Mich.

LATCH FOR SEAT AND BODY CONSTRUCTION FOR MOTOR VEHICLES — Adapted to engage the body at the ends of the seat and secure the seat in both operative and inoperative position. Patent 1507556. V. W. Page, c/o Victor Page Motor Corp., Melrose Ave., Stamford, Conn.

SHOCK ABSORBER—Of the cushioning type adapted for positioning between the frame and axle. Patent 1492731. B. Kerr, 371 Cromwell St., Sarnia, Ontario, Canada.

DENT-IN REFLECTOR—Providing a minimum of glare and a maximum of light to the headlight of an automobile. Patent 1506339. B. F. Gift, Dunkirk, Ind.

INNER TUBE FOR PNEUMATIC TIRES—So arranged that the inflated tube will carry in reserve an inner tube, to be inflated if required. Patent 1506161. W. A. Caldwell, 13 San Carlos, Manila, P. I.

BRAKE—Which will give instant and positive action when operated, designed for use as a vehicle brake. Patent 1506582. K. P. Hangl, 1133 Tinton Ave., New York, N. Y.

AUTO SIGNAL—Which will signal to a driver in the rear the intention and operation of the car ahead. Patent 1507455. B. Blackmore, 1923 Tonawanda Ave., Akron, Ohio.

TIRE REMOVER—For removing tires from disk, wire wheel and continuous type rims. Patent 1507208. O. C. Schlenker, 4015 Pacific Ave., San Pedro, Calif.

ARTICLE HOLDER—More particularly intended as a combined automobile curtain and tool carrier. Patent 1506923. B. Eachus, 611 1st Ave., Gallipolis, Ohio.

SIGNAL DEVICE FOR MOTOR VEHICLES—Consisting of a single unit readily applied to the rear of any ordinary car and operated from the driver's seat. Patent 1507847. H. Mayer, 6 W. Superior St., Chicago, Ill.

DETACHABLE RIM—Which may be readily and quickly secured to or removed from a vehicle wheel. Patent 1507564. P. M. Aden, Valley Park, Miss.

Designs

DESIGN FOR A TOY AUTO CIRCUS ANIMAL CAGE—Patent 65320. L. S. Bixler, c/o Kenton Hardware Co., Kenton, Ohio.

DESIGN FOR A TOY AUTO CIRCUS CALLIOPE—Patent 65319. L. S. Bixler, c/o Kenton Hardware Co., Kenton, Ohio.

DESIGN FOR HANDKERCHIEF — Patent 65376. F. D. Lago, 256 W. 28th St., New York, N. Y.

DESIGNS FOR AN EMBROIDERED TEXTILE FABRIC—Patents 65387 and 65388. B. Schwartz, 130 W. 29th St., New York, N. Y.

DESIGN FOR A LAMP PEDESTAL OR OTHER SIMILAR ARTICLE. Patent 65423. J. Sohn, 109 E. 14th St., New York, N. Y.

DESIGN FOR A WEATHER VANE—Patent 65476. F. X. Herfort, Gingrass Ave., Bergenfield, N. J.

DESIGN FOR A PLAQUE—Patent 65479. E. Klein, 26 Park Place, New York, N. Y.

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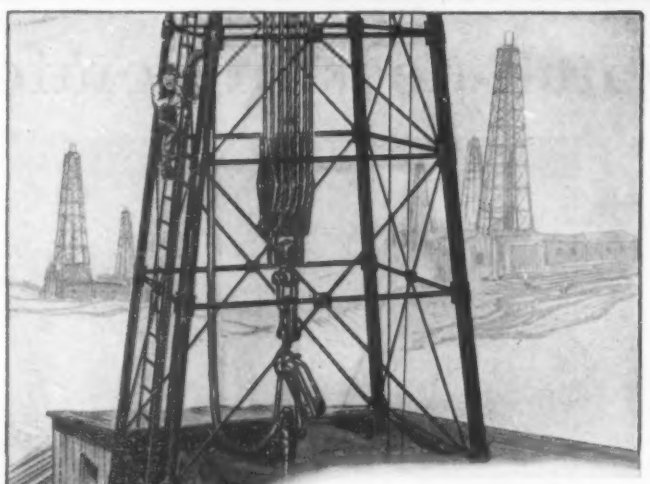

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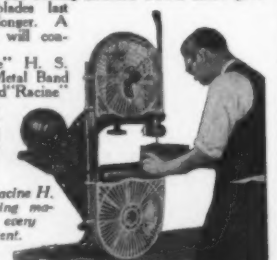

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A Clock Made of Straw.—A unique clock, which from the point of view of curiosity and ingenuity probably surpasses anything ever made in this line, is now on exhibition in Munich (Germany). It is made entirely of straw, is a very accurate timekeeper and contains no springs, no metal of any kind and in fact no other substance than straw, not even glue. It has been going for the past seventeen years and has required no repairs during all that time. The mechanism consists of a weight of two hundred grams, that is raised by pressing on a knob, and an arrangement of eight pendulums in place of the usual wheels. It is 170 centimeters high and 64 centimeters wide. Its front is built in the style of a miniature cathedral, the workmanship of the face being particularly fine. The hands are also moved by pressing on a button. The necessary rigidity was obtained by filling a stalk of rye straw with several other stalks of lesser thickness. Rye straw has been used in the entire construction with the exception of the hands and numbers, which are of oat straw. The clock was built by a shoemaker of Strasburg in the Uckermark, and has been exhibited in various European countries, arousing particular interest in Geneva, the center of the clockmaking industry. It is for sale for 50,000 gold marks (about $12,500) and the maker is said to have been offered this sum for it. His only reason for parting with it is to secure funds with which to build a new freak clock, without wheels, for which the plans have already been completed.

New Glue Product.—After years of experiment an Austrian firm, the "Aktiengesellschaft für Chemische Produkte" has produced glue and gelatine in drops in solidified form, which they have called "Pearls of Glue" and "Pearls of Gelatine." These drops are made by passing the glue or gelatine solution through small holes into an appropriately cooled liquid or gaseous medium. The process is so skilfully contrived that the drops, which assume a pearl shape because of their surface tension, maintain their original quality and suffer no premature loss of glue or gelatine. Numerous advantages are claimed for this form of glue as against the older ones; chiefly economy in manufacturing through the elimination of the processes of casting the jelly on the glue table, the drying, cutting, packing, etc. Furthermore, the glue pearls offer considerable advantages to the user. For instance, whereas it frequently takes several hours to swell old-fashioned glue, the new pearls will absorb the same amount of water in half an hour. This will be made clear immediately by the following comparison. An ordinary glue sheet of about 328 square centimeters surface, can be divided into 262,500 pearls of one millimeter diameter, with a surface of 8242 square centimeters or 25 times the surface of the sheet. Furthermore, the handling is immensely simplified, no breaking of the sheet being required. Daily tests of the quantity of the drops required for manufacturing purposes can be made and the consumer can then make mixtures of the drops presenting uniform viscosity, adhesiveness, as well as the desired melting point; in other words a specific glue for a specific manufacturing requirement. The makers claim that these glue pearls will revolutionize the glue and gelatine industry.—*Abstract from Herman Stadlinger, Neue Freie Presse.*

Are There Biologic Rays?—Some exceedingly interesting experiments have been made recently by a Russian scientist, Alexander Curwitsch, on the subject of cell division. While it has been known that all young living cells, after attaining a certain growth, divide into two, the daughter cells again dividing, and so on, no cause has ever been discovered for this behavior. Mr. Curwitsch inflicted local wounds on animal fibres and observed that the impulses to cell division originating from these points proceeded in straight lines, never curving, and were even reflected when striking an obstacle. Briefly, the impulses showed all the characteristics of a ray. He claims that a type of radiation, which has been unknown so far, must cause cell division. Two interesting experiments with thread-like onion roots were the following: Radiation seemed to originate from the onion and to proceed to the end of the root. If the root be given a curve by passing it through a bent glass tube, the hypothetical bundles of rays must be reflected from the inner walls. Therefore, more rays would strike one side than the other and consequently a greater cell division should take place on these points. Microscopic section of these points show an increase of 10 per cent in the cell division. Still more striking is the following: The end of a straight root of onion was placed opposite another onion, with a space of one or two millimeters between them. The roots did not touch each other and remained three to four hours in this position. An increase of cell division was noted in the second root, opposite the end of the first one. This would indicate that the rays were able to penetrate an air cushion of one to two millimeters and still remain effective. If, however, the point of either of the roots was brought out of alinement so that they were not directly opposite each other, no increase of cell division took place even though the distance was not increased. This would indicate that the effects are not due to a gaseous chemical product but, apparently, to an actual straight-line radiation. It is still quite unknown what this biological radiation is and, indeed, the experiments themselves are so striking as to stand in need of substantial confirmation before they are likely to be generally accepted.—*Abstract from F. Weber, Die Umschau*, vol. 28, p. 317 (1924).

Exploration of the Higher Layers of the Air.—Exploration of the upper air made in Java, where the meteorologic conditions are very favorable for this purpose, were described recently in a lecture by the distinguished Dutch professor van Barmelen, made before the "Gesellschaft für Erdkunde" at Berlin. Recording balloons were employed and in the clear air the bursting of these balloons could be observed through the telescope at heights of 22,000 meters, whereupon the recording instruments came down unhurt attached to the parachute. The temperature of air sank to 55 degrees below zero, Centigrade at a height of 11,000 meters and to 85 degrees below zero at 17,000 meters. The coldest temperature measured was 91 degrees below zero, Centigrade. In still higher regions the temperature of air increases again, the temperature at 26,000 meters height having been found to be 55 degrees below zero. Balloons of two to three meters diameter carried the recorders up to the height of 32,000 meters, more than had ever been obtained before.—*Abstract from Die Naturwissenschaften.*

A New Use for Insects.—By collecting beetles and other insects, the farmer can not only rid himself of the possible damage that they do, but can find a profitable use for the beetles. Chemical tests show that a common German variety of beetles contain 70.5 percent water. But of 100 parts of the dry residue of 29.5 percent it has been found that 55.3 percent is nitrogenous substance and 10.9 percent fat. When dried and ground coarsely the beetles may be mixed with the same quantity or double the quantity of crushed barley and form an excellent pig feed. Powdered dried beetles have been found to contain as much as 58.6 percent of nitrogenous substances and 25.5 percent of fat. The beetles are also valuable as fertilizer. That the values involved are by no means inconsiderable is evident from the fact that in one year, in the province of Saxony alone, 3000 tons of these beetles were mixed with chalk and used as fertilizer.—*Abstract from Die Gartenlehre*, 1924, p. 454.

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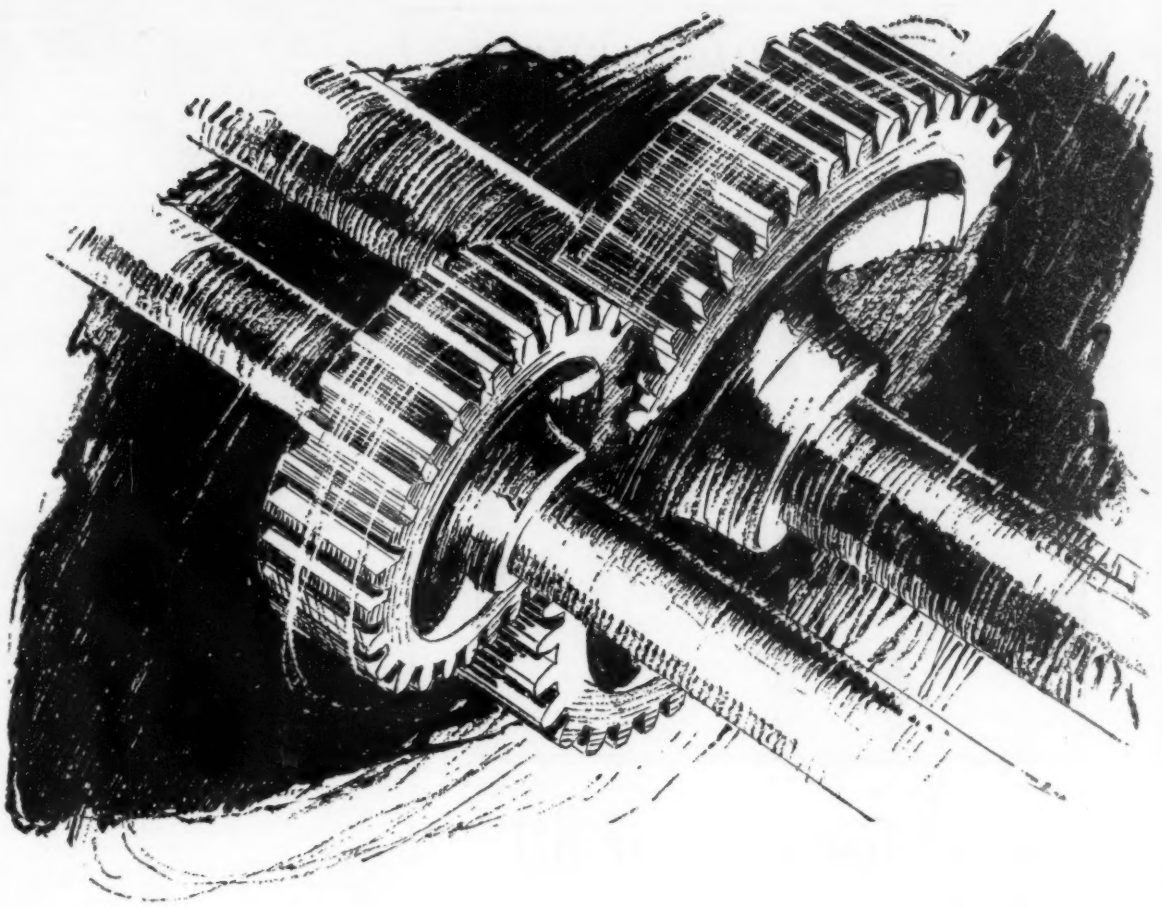
Astronomer Saves Criminal by Calculations of Moon.—An interesting criminal case was tried not long ago at Bozen, in South-Tyrol, Austria. A mysterious crime had been committed at night near the frontier of Italy. Two brothers, both professional smugglers, were suspected of the crime and were taken into custody. Circumstantial evidence pointed strongly toward one of them. In his defense he could assert only that he had left a certain inn on that night after the moon had set. He had waited purposely until the moon had set (which was confirmed by all the witnesses), because he intended to pass the frontier at a forbidden point and because he feared to be seen by the sentries if he attempted this by moonlight. Consequently, the point on which the trial turned was this: At what hour had the moon, seen from the specified inn, set on that night and was it possible to go from the inn to the place of the crime in the time beginning at the moment of the setting of the moon and before the known moment of the crime. In this situation the lawyer for the defendant applied to an astronomer with the question whether the exact moment of moonset could be calculated with sufficient precision. The task was a difficult one. The region was very mountainous. It was necessary, therefore, to ascertain the place of the inn on special maps, to construct a longitudinal section, from these maps, to calculate the course of moon and to fix the exact point of the horizon on the mountains. The precision of the calculation was computed as two minutes, which was sufficient for the purpose. The alibi of the defendant was sustained and he was acquitted.—*Abstract from Die Gartenlaube*, 1924, p. 492.

Shadowless Miner's Lamp.—The ordinary miner's lamp is fitted with rods connecting the upper and lower parts. These rods throw shadows which, at a distance of about two yards, have a width of about eighteen inches so that the miner is forced to frequently interrupt his work, walk to his lamp and turn it to avoid the shade on his work. Furthermore, the usual lamps have some glare and while efforts have been made to overcome this glare by using opal glass or frosted glass, these experiments caused a considerable loss of light. A new lamp which appears to avoid both the shadow and glare defects has just been brought out by a company in Westphalia (Germany). This lamp is provided with a globe covered with a layer of crystalline, stony material which gives a light very similar to daylight. As the light is indirect, the illumination is much more evenly distributed and the support rods cause no shadows. Furthermore, the workman cannot be dazzled by the glare and the soft light is said to have a decidedly helpful influence on the eyes. The importance of such a light can be appreciated when one considers that, according to investigations in England, Belgium and Germany, approximately 20 per cent of all miners suffer from mystagmus or trembling of the eyes. Although few of the sufferers are incapacitated for work there is a very considerable loss through temporary disability and reduced output. In England, where over 6000 miners cannot work because of this disease, it is estimated that it caused a loss in 1922 of a million pounds sterling.

New Spring-Gear Power Transmission.—A German engineer, Mr. Schieferstein, is utilizing swinging masses and springs for the transmission of energy. By the help of the springs the shocks and oscillations which are bound to occur in all machines having reciprocating masses, are entirely eliminated. With ordinary reciprocating machines, such as steam engines and piston pumps, the number of revolutions per minute varies with the load while the length of stroke remains unaltered. Mr. Schieferstein's spring-gears, however, permit the altering of the stroke without changing the number of revolutions. By means of this device it is possible to adjust automatically the speeds of the driving and the driven shaft, according to the load that is being carried. This principle can be used in the construction of simple mechanical power transmissions, for example, in automobiles, the device effectively protects the engine from shock and permits an automatic adjustment of the transmission to changes of speed. Mr. Schieferstein's principle may be used advantageously, also, with the so-called Duplex pumps. These are piston pumps directly connected to steam engines and working without a flywheel. Owing to their low speed these pumps are usually both expensive and unwieldy, but by coupling the



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reciprocating masses to each other with springs it is possible to increase the number of strokes considerably, with resultant improvement in the speed and capacity of the pump.—*Abstract, Zeits. Verein deut. Ing.*, No. 8, 1924, p. 31.

Gasoline and Oil from Coke.—It is well known that the carbonization of coal at low temperatures (up to 450 degrees Centigrade) supplies products far different from those produced by the old method, in which a heat of about 1000 degrees Centigrade was used. The new method is, in reality, a distillation of the volatile ingredients which the coal contains, and is not an actual destruction, as in the great heat of the old coke furnace. For many years the oil shale and the German brown coal of Germany have been worked up thus by low heat. In this manner they supply both oils and paraffin, low-temperature carbonization for ordinary coal was tried first during the great war, to get the much needed gasoline and oil, it being known, that such substances have been extracted out of different sorts of coal by solvents like benzol. Later on the engineers in the great coal districts built special furnaces, long inclined tubes down which the coal glides in small pieces or dust, thus disengaging its volatile elements. The coke produced by this method is of a different kind from that produced by hot coking. It is soft, crumbly and breaks into small pieces. Therefore it is not possible to use it for iron-working. It may be used, however, for gas production in special generators or may be pressed into briquettes. But the most important result of the new low-temperature methods of coking is that the tar obtained is composed of substances like gasoline, heavy oils and phenols. The tar obtained from the old method of coking contains, as is known, only benzol and the higher derivatives of this class, these being worked up into dyes and pharmaceutical preparations. The new tar does not contain such products, but it is produced in larger amount, equaling between 3 and 6 per cent of the coal worked up, as against only 1 to 1.5 per cent of tar from older methods. This result was good, but the low quality of the coke and the great quantities of phenols in the tar were inventives to further effort. As it seemed to be impossible to get better coke by low temperature coking, the chemists endeavored to convert it into more valuable products. The difficulties seemed great, especially, to find methods for converting the coke into products like gasoline. But the chemists succeeded in the following manner. Hot coke treated with water produces a mixture of carbon monoxide and hydrogen called "water-gas." Professor Fischer, the director of the Coal Research Institute in Mühlheim-Rhur (Germany) found it possible to get new products from this "water-gas," when he compressed the gas to 150 atmospheres (nearly 3300 pounds per square inch) and added substances to accelerate the process, for example, hydroxide of sodium put on iron filings. Then, at a heat of about 450 degrees Centigrade, in a few days time, moderate quantities of an oil were produced. This oil is a mixture of alcohols, ketones, fatty acids, etc., but it does not supply the expected good motor fuel. Fischer named this product "Synthol," because he had obtained it by converting coke into higher derivates of carbon. Next he tried to convert this "Synthol" into products more like motor fuel. He succeeded finally by heating it again under a high pressure. He now obtained a product, named by him "Synthin," which is very like the ordinary gasoline used for automobiles and other explosion motors. This shows clearly that it is possible to obtain from coal valuable synthetic products for technical purposes. A special advantage lies in the fact that coals of very low heating value and of high water content may be used; coals that would not be usable for any other purpose.—*Abstract from a German paper by Otto Gerhardt.*

A New Austrian Glass Substitute.—Word has been received from Austria to the effect that a new glass substitute has been discovered which possesses, it is claimed, all the good qualities of glass with few or none of its bad qualities. The new product is known by the name of pollopas. It is a synthetic colloid, and all that is known now of its manufacture is that it is an intermediate condensation product formed by the action of formaldehyde on carbamide. This places it in the class of artificial resins, which since their discovery have developed a field of their own and are now used to manufacture a great variety of articles of common every day use. They include, for example, such products as bakelite. The most interesting properties of the new product are its entire lack of color and its transparency, as well as the high lustre that its surface attains on polishing and its strength. Investigations of it have been made at the University of Vienna. It was found that pollopas absorbs more of the ultra-violet rays than glass and hence it is recommended as a valuable substitute for glass where the ultra-violet rays must be excluded. The index of refraction is about the same as for flint glass. Its light properties are such that it can be used with very good results for making all kinds of optical apparatus. Its hardness is about the same as that of mother of pearl or of the similar phenol-formaldehyde condensation products. Its tensile strength is considerable. These properties imply that it may be a useful product which will have many applications. It does not break easily and is said not to splinter like glass. It has been suggested for making billiard balls, for covering the keys on the keyboard of the piano, for making automobile windshields and the windows of closed cars. As it can be colored and darkened in any shade, it is possible to use it in making artificial porcelain and opalescent glass. Pollopas can be etched with strong sulfuric acid which makes it possible to use it in making door signs and illuminated advertising signs.

One of the Greatest Engineering Works.—Everyone has heard something about the Great Wall of China, but just what a tremendous feat of engineering it represents, one that our largest construction companies today might be proud of is not generally known. It is undoubtedly the most gigantic defense work ever produced and at the same time the most colossal building, from point of contents, ever erected. Begun under the Emperor Shi Hoang Ti, 200 B. C., more than two thousand years ago, it still stands practically intact and seems capable of withstanding the ravages of another two thousand years. It was erected at the northeastern frontier of the then Chinese empire to keep off the attacks of the savage Mongolian tribes. From twenty to thirty feet high, at the base thirty feet thick, dwindling to twenty meters at the top, built of mighty granite blocks, the wall extends along the mountain ridges, upward to the highest summit, dipping into profound gorges and mighty valleys, at times disappearing in the cloud-wrapped peaks, or again lost to view by projecting shoulders, only to break into view again in all its majestic grandeur miles beyond. No obstacle was too great to overcome. What an immense effort was required to erect this bulwark, extending from the coasts of the Yellow Sea to the interior of the Gobi desert measuring, with all its branches, more than fifteen hundred miles in length. The Great Wall contains three hundred million cubic meters of material; as much as 120 Great Pyramids of Cheops. Here is a field for the statistics fiend to delight in. What time must have been spent in its building! How many men must have labored at it! And what a superhuman task they must have performed! For its greater length the Wall runs along bleak and inhospitable mountain ranges. Here is no easy water transportation, such as the Nile furnished for the Pyramid builders; each huge block must have been dragged painfully up mountain ranges of sometimes 5000 feet altitude or more; down steep and precipitous canyons; across turbulent and unbridged water courses. How was it done? How many animals were used? How many animals and men must have perished in its construction? We who today take great enterprises like the Woolworth Building the Muscle Shoals Dam and such engineering feats almost as a matter of course, may stop and ponder for a moment on the achievements of the old Chinese engineers who worked when there was no steam traction, no electric or hydraulic drills; nothing but human labor and bare hands.

Is This a New Case of Perpetual Motion?—According to reports from Germany an engineer named Otto Conrad, recently demonstrated to representatives of the press a new device alleged to be capable of generating electricity virtually out of nothing. First a demonstration of the efficiency of the device took place. The apparatus was fed with a current of 40 watts energy and delivered seventy-five times this amount, as was demonstrated by using a number of 300-watt electric light bulbs. During this demonstration the device was closed so that there was no method of observing what really took place or whether it was fed from a separate conductor. However, experts affirmed that this was impossible by reason of

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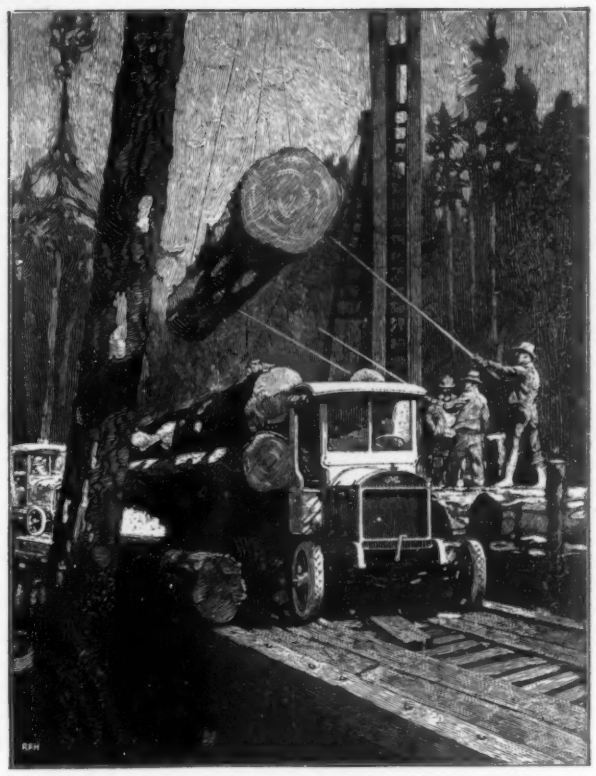
the disposition of the apparatus and measurements which were taken during the demonstration. Later the machine was taken apart in the presence of the spectators and it was shown that there were no outside connections. It is claimed that the machine consists only of pieces of metal connected to each other by wires and partially magnetized. The patent agent who was in charge of the demonstration stated that he had refused at first to apply for a patent since the results claimed were in contradiction to known physical laws. However, by working with the inventor and by practical demonstrations he became satisfied that the effect claimed is really produced. The inventor believes that some phenomenon takes place similar to the action of radioactive substances, but the scientific world will doubtless remain skeptical.

What Ages Can Animals Attain?—The highest age that can be attained by the various species of animals is very different and no regularities have been observed. Among mammals it can generally be said that the large animals live to be older than the small ones, but this law is not valid among the birds, the parrot, for example, reaching the same age as the eagle. Several kinds of polyps live for 50 years; the leech up to 27 years; the river crawfish 20 years; spiders mostly 1 to 2 years. Beetles have been kept prisoners 5 years. The queen bee often lives to be 5 years old, while the working bees usually live for only 6 weeks. Ants were observed in captivity up to 15 years. The toad is said to attain 40 years. A turtle was kept in captivity 150 years; the specimen in question may have been as much as 300 years old. The age of birds is known best. The household cock lives 15 to 20 years, the goose and the eider-duck 100 years; the swan 102 years; the fish-heron 60 years; the stork 70; the falcon 162; the golden eagle 104; the vulture 118; the horn-owl more than 68, perhaps 100 years; the blackbird 18; the canary as much as 24; the parrot above 100 years. Of the mammals the ass sometimes attains 106 years; the horse 40 to 60; the sheep 20; the dog 28; the cat 22; the elephant and the whale 200 years.—*Abstract from recent book, Der Tierkörper als Selbständiger Organismus, by R. Hesse.*

How Dangerous Is a Wild Crowd in a Gymnasium Balcony?—Evidently not quite so dangerous as one might fear, if one may judge by experiments made by Prof. A. H. Fuller of the Department of Civil Engineering of Iowa State College at Ames, Iowa. Cheering, stamping, jumping, excited crowds of college "rooters" increased the static or resting load on a gymnasium balcony by amounts up to 155 percent, coverable by a three to one factor of safety by a narrow margin and by a five to one factor quite safely. The test floor was a balcony in a gymnasium. It had been designed as a running floor and was supported from above by suspension rods. The floor beams were double, eight-inch channels projecting out from the walls of the building, and were supported at the outer ends by the suspension rods. These beams were spaced twelve feet apart and carried timber stringers and a plank floor. Measurements of static and of dynamic stresses on both the suspension rods and on the floor beams gave almost identical increases when the crowd was jumping, thus checking the methods and results. Mere swaying of a crowd appears to produce moderate impact effects of ten to thirty percent above the weight of a quiet crowd. Vigorous delivery of the college yell, which involves a considerable jerking of the bodies of the yellers in unison, produces impacts up to fifty percent above the static load of a quiet crowd. But deliberate, and rhythmic movement or jumping of the whole crowd increased the total load by double the static load, and sometimes by half again as much more. For example, forty-one men weighing a total of 6,300 pounds, spread over fifty-four square feet of floor area, gave a floor load of 116 pounds per square foot and a static stress in one of the suspension rods of 2,100 pounds. When these men teetered on their toes at five-second intervals the stress on the suspension rod went up to 5,600 pounds, representing an additional dynamic stress of 165 percent. This would be just covered if the factor of safety in the design were about three to one, which must be considered, therefore, to be too low a factor of safety for such a place. Stresses produced by cheering in unison, rising and dropping on the toes at two-second intervals, swaying in standing positions, jumping and other antics, were all lower than the one indicated above. The factors of safety usually allowed for



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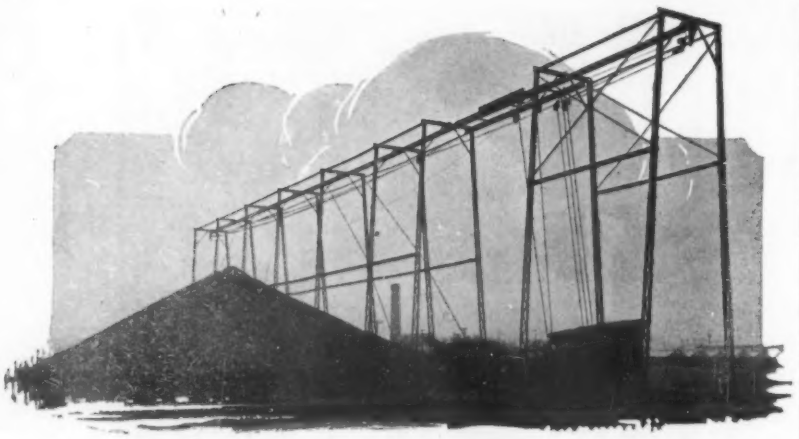

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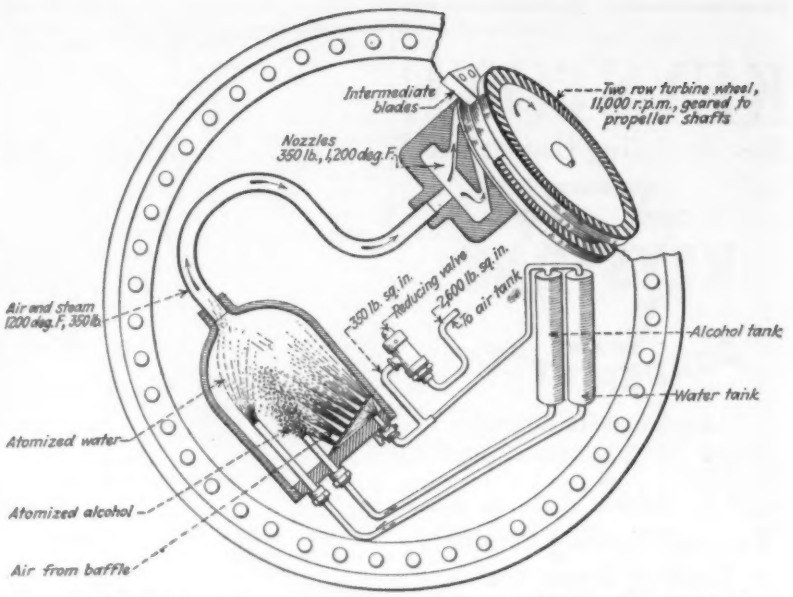

Cross section of the new steam turbine torpedo. The boiler is unique. In it the water is sprayed directly against the flame.

such structures vary, but a factor of only three to one would not ordinarily be considered as high enough for a balcony or bleacher. While there is never any absolute assurance that the proper factor of safety was originally complied with in constructing a given balcony, or that subsequent deterioration in materials has not reduced the safety factor, the Iowa State College experiments indicate that the danger of remaining in most balconies with wild, stamping crowds is not so great as the noise and confusion might make one think.—*Engineering News-Record* (New York), vol. 93, page 231 Aug. 7, 1924).

Two Hundred Horsepower from a Twenty-pound Turbine.—The temperatures at which steam is used in engines have increased during the past ten years at a steady rate, but indications now show that we are ready for a much faster increase. Elevating the temperatures of steam offers greater theoretical possibilities of increasing plant efficiency than does any other means. To get high efficiency in a steam engine there must be as much difference in temperature as possible between the entering steam and the exhaust steam as it leaves. This largely accounts for the considerably higher thermal efficiency of the gas engine over the steam engine, as the latter is now used at what we call "ordinary" pressures. These ordinary pressures, by the way, will doubtless be called low pressures tomorrow. At 750 degrees Fahrenheit, steam pipes are so hot that they glow red in the dark. If a practical way can be found to use steam at, say, 1,200 degrees Fahrenheit, a gain in efficiency of about sixty percent can be had. A peculiar type of steam plant in which steam is used at this unusually high temperature has recently been perfected in the form of the steam turbine torpedo. Most torpedoes are driven by compressed air. The new steam-turbine torpedo contains, however, a miniature twenty-pound turbine which develops 100 to 200 horsepower. The boiler is only 8 inches long and is not a boiler in the usual sense, for the water which is to be turned into steam is sprayed directly against the flame. This consists of alcohol burning in air from a tank. Left alone, the flame would reach a temperature of some 1,600 degrees. The effect of the direct spray of water against the flame is to lower the flame temperature to 1,200 degrees. Were this not done the pipes and turbine parts, heated to a temperature as high as 1,600 degrees, would retain little mechanical strength. The steam pressure is approximately 350 pounds a square inch, and the steam carries about 700 degrees of superheat. The turbine proper is eleven inches in diameter and revolves at 11,000 revolutions a minute. The blade speed of the torpedo propeller is 525 feet a second—about six miles a minute!—but this does not, of course, represent the considerably lower velocity of the torpedo itself. Regarded either as a highly particularized type of steam power plant, or even as a mechanical toy, the steam torpedo using steam at 1,200 degrees may serve to point the way toward a simplified and more efficient type of steam plant than is being used today. The boiler plant is simple, for the water is sprayed directly against the flame. The problem is largely one of metallurgy—the development of alloys which will be strong enough to confine steam at high pressures while at temperatures at which iron is red hot and has very little strength left. Elevating the steam temperature is relatively more productive of increased efficiency than is increasing the pressure. Thus, if you have steam at 400 pounds pressure, and double this pressure, you will gain no more than can be got by raising the temperature from 700 to only 1,000 degrees.—*Power* (New York), vol. 60, pages 405-406, and editorial, page 423 (Sept. 9, 1924).

What Good Was the World Flight?—This question has been asked by millions. Like many another thing, there is altogether more good in it than is apparent to the casual eye. The world cruise has been a test of the reliability and endurance of the modern airplane, concludes Prof. Alexander Klemin of the Department of Aeronautics, New York University. The world flight showed that the fire hazard has already been largely eliminated. It has proved the reliability of the general fusilage design. It has indicated many possibilities for future development in the power plant. Except that for the long flights the fuel tanks were increased in capacity, the planes were stock models. This fact increases confidence in the ability of the airplane to become a practical, everyday method of travel. One hears objections to the large outlay for spare parts and motors. Distributed along the route were engines for six changes of motors and spare parts for fifteen Liberty motors and for eight planes. Along the water routes there were fourteen sets of pontoons, and on the land-flight routes there were forty-two landing gears. Does this tend to show that the airplane is dependent on repair and supply? Yes. The fact that these were needed only emphasizes that in future, for long-distance flight, there must be complete ground organization, with fields, spares and mechanics, weather and radio service, naval and coastal stations. It was proved, in the opinion of Prof. Klemin, that pontoons for seaplanes should be of metal, to minimize the soakage which, at Chittagong, India, prevented the planes from taking off. It is also evident that the doped linen or cotton covering for wings must yield to metal, probably duralumin. A third lesson is that ships for use in the tropics must be designed with a lesser loading per square foot, to compensate for the lighter atmosphere. The technical lessons regarding the planes, engines and equipment will take months to interpret. The fliers took copious notes and were not just flying for fun. There will be much invaluable data. Perhaps least valuable in its immediate implications, but most valuable in a deeper sense, is the effect of the world-flight on the morale of the air service—the response to the spirit of enterprise and adventure that has brought the white races to the world supremacy that is theirs. In the days of Magellan there were doubtless people who said, "Yes, but what good is it?"—*Automotive Industries* (New York), vol. 51, pages 397-400 (Aug. 28, 1924).

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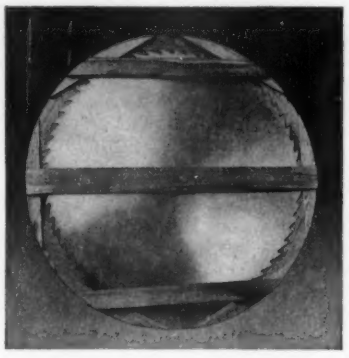

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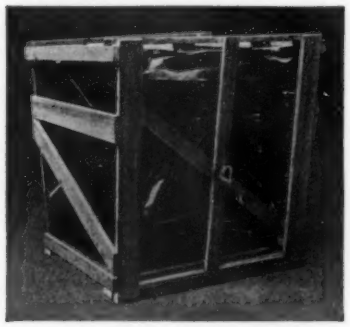

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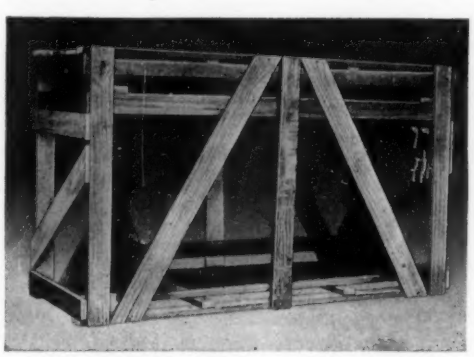

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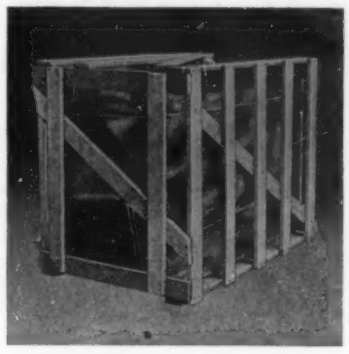

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Yours very truly, M. W. Longfellow
First Vice-President
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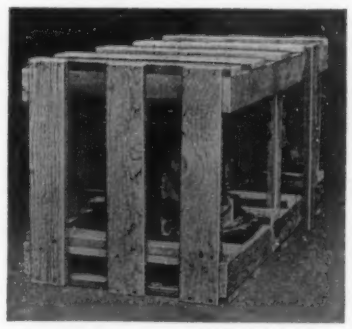

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"Safety Last."—We have lately been having an epidemic of daredevil stunts, some of which have ended fatally, as in the case of a human fly who attempted to scale the wall of the Martinique Hotel in New York, but fell to his death. Such exhibitions were tolerated when Liberty Bonds were being sold, but the police should stop such things now before the potential victim leaves the ground. Those who emulate such exploits have phenomenal strength in their hands. A Canadian trying to smuggle into the U. S. to avoid paying the head tax of $8.00 which he did not possess, walked across the bridge above the rapids on a 10-inch girder. A huge crowd watched his progress, expecting to see him plunge into the seething water below, but he safely reached the abutment. His exploit was all in vain, however, as there was a sprinkling of immigration officials in the crowd and these promptly returned the would-be immigrant to the Canadian shore, this time using the top of the bridge. Speaking of fatal accidents, there was a suicide the other day from the Washington Monument, the victim having just been released from a sanitarium. He stole up the stairs and precipitated himself to the ground 504 feet below. We omit the harrowing details, which ran true to form in that every bone in his body was broken, etc., and proceed to the scientific aspects of the tragic descent. Scientists have figured out that his descent occupied 5.6 seconds and the force with which he struck was 300,000 foot pounds.

Buses on English Railways.—Britain is following the American example of running buses on branch railroad lines where full trains are not profitable. The North Eastern Rail· ay Company is now furnishing a railed motor service from York, England, to several small stations along its lines.

Egyptian to Try for World's Automobile Speed Record.—An Egyptian sportsman, Mr. Djelaleddin, hopes to break the world's short-distance motor car speed record of 168 miles per hour, established by Malcolm Campbell on the sands at Pendine, Wales, in 1924, and for this purpose he is building a 400-horsepower car designed by an Italian engineer. The car is not a freak, except that the rear tread is reduced from the standard 56 inches to 37 inches, thus saving a little weight. Still more important, this makes it possible to do away entirely with the differential gear. The motor is a straight eight, with cylinders 4.2 by 5.5 inches (610 cubic inches). It developed 355 horsepower on its first bench test. The crankshaft is mounted in nine plain bearings. The pistons are aluminum. Experiments have been made with an individual carburetor for each cylinder and an individual supercharger for each carburetor. The whole car is scientifically streamlined. This is thought to be the first modern European car built from the ground up with a view to making a high speed record. Previous models have been extemporized, at least in part, from aviation engines and from chassis of more or less makeshift nature.—*Automotive Industries* (New York), vol. 51, page 407 (Aug. 28, 1924).

Getting the Gas Into Your Motor Cylinders.—As a result of the careful experimental studies made recently of the distribution of the gas from the carburetors to the separate cylinders of motor cars the modern automobile designer is showing a strong tendency to fit multiple carburetors to his engines. Sometimes two carburetors are used, or at least a single carburetor having two separate jets. This tendency reaches its extreme in the racing car, where engines having eight cylinders in line have even been equipped with eight carburetors. When the gas from the carburetor has to negotiate a sharp turn the greater mass of the molecules of gasoline, relative to the mass of the molecules of air, gives them greater momentum. This disturbs the homogeneity of the gas and it becomes "stratified." The gasoline may tend even to come out of solution in the air and actually to become liquid again. It is extremely difficult to design inlet passages so that each cylinder will always get its correct share of gas. For example, tests made on a high-grade four-cylinder car in which the engine was run successively on each cylinder alone, showed the following results: No. 1 cylinder gave 270 revolutions per minute; No. 2 cylinder gave 258 revolutions per minute; No. 3 cylinder gave 276 revolutions per minute; No. 4 cylinder gave 288 revolutions per minute. The difference in power, as indicated by speed, is seen to be about ten percent. But, on opening the throttle a little, the same cylinders gave respectively 625, 645, 650, 615 revolutions per minute. The difference in power production fell about six percent, but a curious thing happened at the same time; No. 4 cylinder, which formerly got the most gas, now received the least. Cylinders No. 1 and 2 changed places also. By opening the throttle still more the curious things that can happen in an inlet pipe were shown. The cylinders showed 1,305, 1,350, 1,335, and 1,315 revolutions per minute respectively. No. 2 was now in the lead. The greater the overall efficiency which the designer aims at; that is, the wider the range of revolutions, the more difficult does this problem of gas distribution become to the respective cylinders. The fact is that by warming the inlet pipe an inlet pipe previously giving a bad distribution can be made to give a reasonably uniform one. But this inevitably implies an encroachment on the efficiency of the engine, for heating the gas increases its volume and the greater the volume to which the gas is expanded, the less the weight of gas drawn into the engine by one piston stroke. The device of a heated inlet pipe is found, therefore, in American types of engine in which smooth running is regarded as more important than fuel efficiency.—*The Autocar* (London), vol. 53, pages 492-495 (Sept. 19, 1924).

Have You Ever Seen Ball Lightning?—Information based on first hand observation of ball lightning has been requested by Mr. W. J. Humphreys of the United States Weather Bureau. So little is known about the real nature of this peculiar atmosphere phenomenon that an effort is now being made to solve its puzzle. Mr. Humphreys desires to get careful, authentic accounts of observed cases in which ball lightning has been seen by the person sending the account, with the fullest particulars of every detail and aspect of the phenomena witnessed. This form of lightning has been the subject of many inaccurate accounts and no greatly scientific determination of its nature has ever been made. For one thing, few professional scientists have ever seen it. Some deny the objective existence of ball lightning, regarding it as an illusion due to some peculiar effect of ordinary lightning on the beholders. Those who believe that they have seen it describe it as a ball of fire moving along slowly, often with a hissing or sputtering noise. It may char articles which it touches or it may leave no effect at all. It may disappear silently or it may explode with a bang. On the whole, there is good ground for believing that the phenomenon really happens, but it is extremely difficult to get careful, cool-headed observation of it. Anyone possessing really authentic information is urged to send it to Mr. W. J. Humphreys, at the Weather Bureau, Washington, D. C.

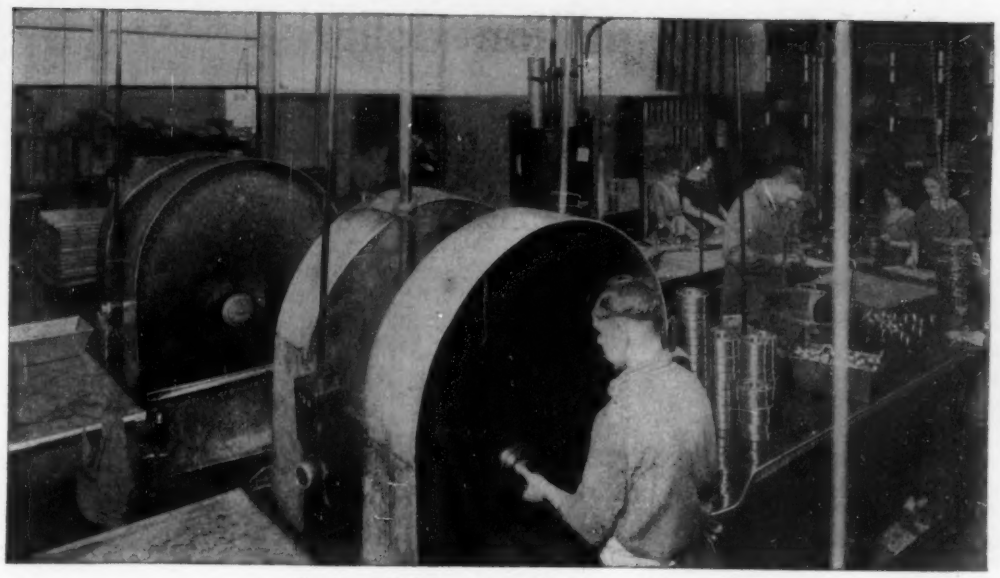
Painting One Ford Every Six Seconds.—By means of a new painting and conveying unit recently installed in the Ford factories, automobile frames are cleaned, painted, dried and delivered in a continuous stream to a car door for loading, at the rate of one every six seconds. This installation has resulted in a fifty percent saving in labor. By its use all handling by hand is eliminated from the time the frame is inspected after riveting until the painted frames are loaded on the freight cars. Before it is painted, the frame passes through a strong caustic solution for cleaning, and then through clean boiling water. Both liquids are in turn sprayed over the frame at pressures of thirty-five pounds a square inch. Then the frames go to a drying section kept at 140 degrees Fahrenheit. Spraying with paint is done by fifteen sprays, the surplus paint finding its way back to the pump. Next the frame, still on the mechanical conveyors, passes through the drying oven, a distance of 500 feet. Automatically, it then passes to the loading platform and is loaded by hand into box cars. One hour and fifteen minutes after the frame is placed on the first conveyor, it has been cleaned, painted and dried. Five to twenty minutes later it is loaded on a car and shipped to the Ford assembly plant.—*The Iron Age* (New York), vol. 114, pages 555-558 (Sept. 4, 1924).

Putting the Black Spot on British Cities.—The exact measurement, from hour to hour, of the amount of smoke pollution in city air was the purpose for which Dr. John S. Owens, of Great Britain, constructed an automatic recorder of unique design. In this apparatus, air is filtered through thick filter paper, and the subsequent color of the paper is compared with that of a standard color scale. A large circular disc of the paper, divided into twenty-four hours, is caused to revolve by a clock.

At small intervals a small spot, one-eighth inch in diameter, is selected near the edge of the filter-paper disc, and through this spot two litres (122 cubic inches) of air are automatically aspirated, leaving behind on the paper a small black spot corresponding to the impurities filtered out. The standard scale for comparison was made by laying successive washes of a standard lampblack suspension on white paper, the number of washes used indicating the number of the shade. The values of these different numbers in practice were originally obtained experimentally by weighing large paper discs through which known volumes of city air had been passed. Hourly tests were made in London and in several other cities. By the use of suitably colored filter paper it was even possible to separate out particular kinds of smoke, representing various industries; such as refuse incinerators, blast furnaces, metallurgical factories, etc. The maximum number of smoke particles in the air seems to occur about nine or ten o'clock in the morning, in most of the cities whose atmosphere was tested.—Paper read before the section of mathematics and physics of the Toronto meeting of the British Association for the Advancement of Science. Reprinted in *Chemistry and Industry* (London), vol. 43, pages 866-872 (Aug. 29, 1924).

Another Lake Superior Copper Region has been found at Coronation Gulf, near the Arctic Ocean coast of Canada. A copper-bearing belt 16 miles wide and of unknown length, the copper occurring as disseminated flakes in basalt, as amygdaloidal copper, and as fissure veins was first located by a Mr. Douglas in 1911. The Douglas expedition was followed in 1915 to 1917 by the Canadian Arctic expedition under Dr. J. J. O'Neill. Dr. O'Neill determined the Bathurst Inlet mineralized area as 50 miles long, with a maximum width of 25 miles. Taken altogether, the indications are favorable for the existence of high-grade mines, as well as larger low-grade deposits in this region. We have, therefore, it is probable, a region comparable, let us say, to the Lake Superior copper region, on the Arctic shores, unprospected and unowned. Conditions for prospecting and mining are not unfavorable, remoteness and the consequent difficulty of transportation being the chief obstacle to further progress. It may seem strange that a region which offers such substantial promise should be treated with silence by mining capital—that another Lake Superior copper region should fail to arouse interest, even with the drawbacks stated. The real reason lies in the character which the copper-mining industry has assumed. The consumption of copper by the world is ever on the increase, and the development of large-scale copper mining at many points has put the industry on a sharply competitive basis. Copper mining has become largely a manufacturing business, much like iron mining. Costs are the factor which determines the successful and profitable copper fields. The reason that the Arctic copper regions are untouched is similar to that which accounts for the neglect of the rich and abundant iron ores of Brazil. They are remote from transportation, from coal, and from the centers of consumption. They constitute one of the world's copper reserves, of which there are probably more than we realize: they will be attacked when we run out of nearer and cheaper copper, and not before.—*Eng. Min. Jour.-Press*, 118:3, 4 pp.

Took No Chances of Fire with "ZR-3." —The millions of cubic feet of hydrogen gas which carried the "ZR-3" across the Atlantic recently, constituted, in the opinion of navy officials, a fire hazard which justified the most extreme precautionary measures. A week before the "ZR-3" arrived at Lakehurst, N. J., an order was posted prominently on all the bulletin boards in the aviation camp which clearly demonstrates the dangers that are incurred in the use of hydrogen in lighter-than-air craft. Paragraph three of this order directed that, until after the "ZR-3" was safely housed and the hydrogen removed from her gas bags, all of the following apparatus in the hangar be put completely out of commission: Overhead cranes; all electric motors inside the hangar; all buzzers and lights in elevators; circuits for all floor lights; starting equipment for deflation motors; radio compass house elevated leads; electric lights over gasoline tanks; fire warden telephone. Another paragraph prohibited the use of all types of electric flash lamps except the special gas-tight miners' electric light; doubtless because there is always a possibility that a minute spark may be produced when the switch is thrown on or off.



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Mud Slinging, a Possible Protection Against Coal Mine Explosions.—If a layer of powdered shale or limestone be spread out on the floors and walls of the main passageways of a coal mine the rush of air that is caused by an explosion in some one part of the mine will raise this rock powder in a cloud. This will act as a fireproof barrier against the spread of the explosion to the whole mine. This is the principle of rock dusting, a new and successful method of saving life and property in mines. Already, rock dusting is mandatory by law in these coal mines of Illinois and Utah, which are subject to gas. It is one of the rare innovations that has not had to fight its way against conservatism, but which is so meritorious on its face that nearly every mine operator sees its value and is considering the installation of the method. Terrible mine fires or explosions—sometimes it is hard to know whether one ought to call them slow explosions or rapid fires—formerly spread because the mantle of the accumulated coal dust in the mine passages was raised by the rush of air due to the explosion. This suspended coal dust then exploded in its turn. In rock dusting, the powdered rock prepared in a grinding plant is usually scattered on the floors, walls and ceilings of passages by means of air jets, much as fruit trees are sometimes dusted against insects. But why not "mudize" a mine instead of dusting it? The superintendent of a mine in Utah has just been experimenting with mud, sprayed on the walls and floor by means of a pump carried along on a mine car. Mud costs less than rock dust, owing to the high cost of pulverizing the rock. The mud coats everything with a layer less than 1/32nd of an inch thick. When dry it sticks. But the mud coating remains soft enough to pulverize again between the fingers. To the superintendent of the Utah mine it seems probable that the force of an explosion, traveling through such a mud-coated entry, might pulverize the dried mud, raise the solid particles into the air, and cause it to subdue a coal-dust fire or explosion, much as rock dust is known to do.—*Coal Age* (New York), vol. 26, pages 391-394 (Sept. 18, 1924).

Tiny Living Granules May Control the Origin of Species.—The living cells, units alike of vegetable and animal matter, are the basis of extremely significant work which are not fully understood, it is quite evident some clue to the origin of species. This comparatively new science, which Darwin never had the least opportunity to know of, gives a new line of approach of fundamental importance in the analysis of the processes of evolution and the hunt for its real cause. Formerly we had the mere observational and experimental study of heredity. Now we have the microscopic study of the cell and its constituent parts, a study to which the rediscovery of Mendel's law in 1900 gave a great impetus and an altogether greater significance. Thus two formerly independent lines of investigation have converged strikingly and have mutually reinforced one another. Your body and mine are made up of cells, each of which has its individual activities. Living cells are not mere drops of jelly, but each contains a complexity of parts, one of which is the solider, easily dyed speck called the nucleus. This nucleus, in turn, contains a number of highly important microscopic constituents called chromosomes, of which each species of plant or animal possesses a characteristic number. Man, for example, probably has forty-eight chromosomes in each cell. Some low forms of worms have only two, but some animals, one kind of crab for instance, have more than man. Now, while the nature and behavior of these little chromosome particles are not fully understood, it is quite evident that they have very much if not everything to do with determining the great facts of heredity. Cells die continually. New ones are made from those that remain, by a wonderful division in which the chromosomes are reproduced with marvelous accuracy. Were this not so, the species would not continue almost unchanged from generation to generation, but different species would be created willy nilly every time that a reproductive cell divided into two cells. It has recently been observed, however, that the usual mathematically exact redistribution of the chromosomes in cell division does not invariably take place. Sometimes there are sudden changes in the number and grouping of these determining units. Sometimes there is seen a transverse fragmentation, sometimes a gradual diminution and disappearance of some of the chromosomes of the group, and sometimes a rearrangement of their bodies. When we learn why these things happen we will know why evolution takes place. On the basis of a study of these irregularities a new science has grown up. It now looks as though we had brought the quest of the final *cause* of the origin of species at least a step nearer to fruition.—Partly from a paper delivered by Prof. R. Ruggles Gates before the joint sections of zoology and biology at the Toronto meeting of the British Association for the Advancement of Science, in August, 1924. Reprinted in *Nature* (London), vol. 114, pages 353-357 (Sept. 6, 1924).

Water Pipes Made of Cement.—Cement linings in pipes do not corrode, and the pipe size is, therefore, not gradually decreased as is often the case where ordinary iron pipe is employed. However, as it seems quite probable that within a few years the public will demand the softening of hard water for municipal supply, and as soft water has considerably greater corrosive power than hard water, it is evident that cast iron pipe, where used for municipal supply, will become increasingly unsuitable unless some sort of a non-corrosive lining is used. Cement is such a lining and its use is far from new. But owing to certain difficulties in making a good joint between lengths lined with cement, its use has largely been discontinued. Within recent years, however, Reeves J. Newsom, Commissioner of Water Supply of the city of Lynn, Massachusetts, has developed a mixture of Portland cement, modified to give the required characteristics—that is, slow set and lack of brittleness. The difficulty experienced in the past has been to get a good joint between the cement linings of pipe and fittings. By using a soft metal lining in the fittings, its proper conformation to shape of the cement lining of the pipe is easily secured. A lip of lead or tin is used. —*Canadian Engineer* (Toronto), vol. 47, pages 283-284 (Aug. 26, 1924).

The Stonehenge Cromlech Is Being Excavated.—Excavations which are steadily being carried on at Stonehenge, the great circular stone monument left at Wiltshire, England, by a long-since vanished race of men, have not revealed anything which would fix the age of the peculiar structure beyond the supposition, held by many archaeologists, that it dates from about 2,100 years before Christ. This was the time (in Britain) of the change from the stone implement Period to the Bronze Age. Stonehenge is so large that the complete excavation of the area would be very costly, but ditches are being run in several directions with the hope of finding any lost and buried articles which would solve the purpose for which it was first built. The outer circle of great stones set on end in the earth has a diameter of about 100 feet. Inside are semicircles of stones, 21 feet high, in groups of three, and other stones which are said to have pointed to the rising sun at the summer solstice, at the time Stonehenge was constructed. If this belief is true, the date when Stonehenge was constructed would be about 2040 B. C., as calculated by astronomy. The present work of excavation has been going on for two years. Traces of early fires have been found, as well as horn picks, bones of animals, and quantities of flint flakes. The remains of a chalk-paved road which crossed the surrounding ditch and afforded an entrance to the circular stone enclosure were recently found. The surface of this road, it now appears, was studded with fifty-eight holes, more or less in regular lines, occupying the entire width and length of it. These were evidently for resisting attack, pointing to the place being one of defense in its early history. Evidences show that many of the stones were first found by the builders right on the site of the monument. The holes from which they were removed were filled with loose chalk arranged just as it slid back into the cavity when the stone was first extracted. Over one of these holes left after the extraction of a monument stone, a dump of nearly 4,000 chips, made when the stone was first dressed, was discovered. Excavation within the 100-foot stone circle by means of 107 trenches brought to light that there were once two more circles of stones outside of the present outside circle. The holes from which these had later been extracted had never entirely refilled themselves. The mason's chips were found about them, showing that the stones were dressed there. Evidences point to this removal of a part of the original monument at a later but still very early date. A great deal of ground still remains to be opened and the work is being continued steadily.—*Nature*, vol. 114, pages 438-439 (Sept. 20, 1924).

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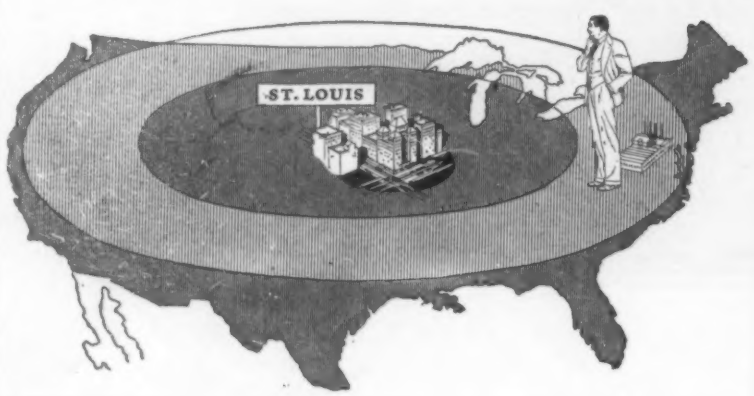

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St. Louis, U.S.A.

How Doctor Steinmetz Got His Middle Name.—Dr. Charles Proteus Steinmetz was frequently urged to write an autobiography but said that it was too much bother. Fortunately, Mr. John Winthrop Hammond succeeded in getting him to tell, orally, much of the story of his interesting life and Steinmetz lived long enough to read and approve a part of the biography that resulted. It is now published in book form by The Century Company, New York. Steinmetz was neither born in poverty nor riches, nor does he appear either to have been abnormally bright as a boy, or to have had the too frequently claimed distinction of failing at his studies. His father, an intelligent railway clerk, in Germany, sympathized with his boy's ambitions to learn and helped all he could. When Germany became too hot for the young socialist student he came, without long previous consideration, to America, borrowing his passage money from a friend. Landing as Carl August Rudolph Steinmetz, his full original name, he at once set out to become an American, changing the "Carl" to Charles and dropping the German middle names. In the German university which he had attended his student nickname was Proteus, "one who changes," for his interests had been always so wide that he was known as changing from one subject to another. Charles Proteus he became; that is what he always called himself; and this is the origin of a middle name which has puzzled many of his American admirers.

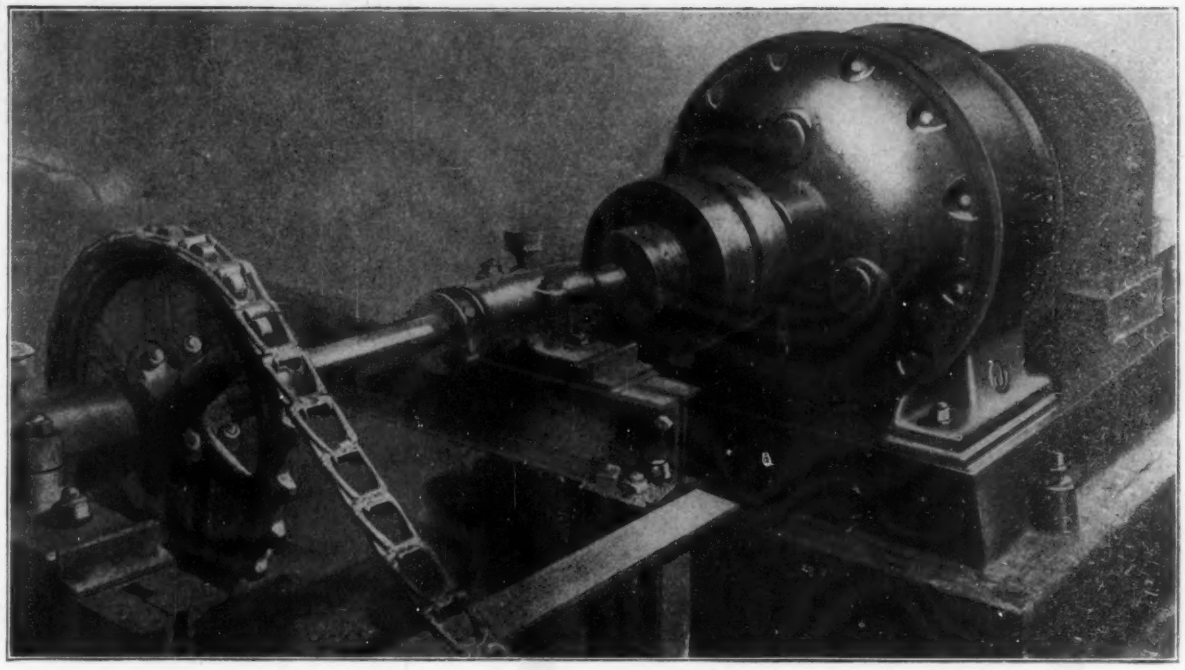
Why Most Mine Explosions Occur at Certain Hours of the Day.—Engineers of the Department of the Interior have been making a careful study of the cause and prevention of the explosion of gas in coal mines. They have found out that these explosions do not occur more or less uniformly throughout the twenty-four hours, but that there are three periods during which most of the explosions happen. First, between six o'clock and nine o'clock in the morning there are many explosions, especially around half past seven. Second, between eleven o'clock and one o'clock, the noon period, the number of explosions increases. Finally, between three o'clock in the afternoon and seven o'clock in the evening, especially at about six o'clock, a greater number of explosions than average seem to occur. How can these three periods of increase of accidental mine explosions of gas be accounted for? Take the first or early morning accident period: The fire bosses whose job it is to watch for signs of explosive gases in the mine generally try to examine for gas before the miners enter the mine in the morning for work. Sometimes, however, they cannot inspect the whole mine, or else they do not, and when the miner with his open light enters some part of the mine which the fire boss has failed to inspect an explosion of gas occurs. Another cause of the frequency of early morning explosions is the leaving of ventilating doors ajar during the previous night. Gassy coal mines have to be ventilated by means of immense air fans placed at the surface. These suck air out of the mine and fresh air must flow in to replace it. In spite of the great power of these fans many parts of the mine would get no change of air were it not for partitions of wood which are built by the miners across chosen passageways. These partitions divert the air from easy routes through the mine and into the out-of-the-way places. Most gassy coal mines contain dozens of these partitions. Since they block the passageways entirely, doorways have to be cut through them so the miners may pass through, and doors have to be provided. Otherwise the air would pass through the doorways and the partitions would fail of their purpose. Often a careless miner leaves one of these doors ajar when he leaves the mine at night, and so the air which should go into various chambers and workings of the mine is short-circuited through the doorway. These isolated chambers, temporarily without ventilation, may then accumulate gas. When in the morning the miners come in with lighted lamps on their hats an explosion of gas occurs. The second or noonday high point in the explosion rate is a result of the practice of firing the explosives, used to break down the coal, at about noon. This often ignites gases which have been accumulating in some gassy chamber of the mine. The third or late afternoon period in the explosion rate is due, in the opinion of the engineers of the Department of the Interior, to the practice of shotfiring. Shotfiring is special work done by a crew of men who do no mining but go through the mine after the miners have drilled the holes, load them with gunpowder or other explosives and fire them all off within a relatively short period of time. This method of specializing has largely taken the place of the earlier method in which each miner fired his own shots. In mines which used this method the shots were not bunched as is now the case where shotfirers do all the firing. These shotfirers often do their work too rapidly. Also, their work often liberates new gas and this is exploded when the night shift of miners comes into the mine.—*From a statement issued by the Department of the Interior, Washington, D. C.*

New Attempts to Find Out Why Explosives Explode.—There is some reason for believing that the difference between stable chemical compounds and the ones that are explosive lies in the tenacity with which the "valence electrons" of the constituent atoms hold these atoms together. In other words, in explosive materials these electrons may not be as firmly hitched to each other as in the case of inert materials. Experiments are now being conducted with a view to making a study of the exact nature of these inter-atomic bonds. Do they exist in the manner predicated? This seems likely, yet it has not been proved. Most of us remember when a teacher of chemistry diagrammed various molecules on the blackboard by using circles for atoms and joining them by little hooks. Some of the hooks were locked with other hooks reaching out from other atoms. These hooks were a conventional method of indicating valence. In some way, it was thought, the atoms of the molecules did hold one another by some kind of peripheral attraction. If the work of the chemist and the physicist, Gilbert N. Lewis, on the nature of the atom is ultimately proved to be correct the atom has certain "valence electrons" which do, after a fashion, "hook" it to the other atoms making up the molecule. Lewis conceives that the atoms in a chemical union of two elements share a pair of electrons. The atom is believed to be composed of a nucleus, whose real nature is still uncertain, and one or more outer electrons which probably whirl about it in definite orbits. Thus we get the familiar comparison with the sun and planets. It is conceived that each element is more complex than the preceding element in the periodic table of atomic numbers by the possession of one additional planetary electron. The electrons are conceived as having a very definite configuration, based on a principle of pairing. The pairs arrange themselves symmetrically in fours, except that the individuals of the first pair seem to take up respective positions on opposite sides of the nucleus. These two form the inner shell. The others form successive outer shells. The ones in the outermost shell of all are thought to be the valence electrons. Now the distinct contribution of Lewis to this subject is the idea that the chemical union of two elements involves the sharing by their atoms of a pair of electrons—perhaps two of the valence electrons. Accordingly the tenacity of atomic bond lies in the completeness of this electronic sharing. This almost gets back to the professor's little hooks again. If the sharing is weak you have an explosive compound. If strong, a stable one which will not explode. Experiments are now being made by exposing minute samples of mercury fulminate, lead azide, etc., to a stream of bombarding electrons. If the velocity of these electrons is high enough to impart much motion to two of the shared electrons and carry them beyond the sphere of influence of the attached atoms, the velocities of the respective bombarding electrons will form a set of indices which can be assigned to explosive substances. This will serve as a quantitative way of describing the relative sensitivity of explosives to detonation. And this electronic conception of the nature of detonation together with the proposed way of investigating its validity, should afford a valuable means of studying the nature of the chemical bond.—*Army Ordnance* (Washington), vol. 5, pages 515-518, Sept.-Oct., 1924.

Distant Control of Machinery by Radio Waves.—By means of radio waves sent out from Kokomo, Indiana, about 35 miles away, switches are being successfully operated in the substation at Tipton, Indiana, furnishing that community with light and power. This station is controlled without the presence of a single attendant. This radio control is not a stunt or freak, but is meant for use in case of emergency. Tipton, a city of 5000 inhabitants, has two alternate sources of power—Kokomo and Noblesville. Heretofore the operation of the

large oil switches which change from one source to the other have required the presence in Tipton of substation assistants. Their orders had to reach them from Kokomo by telephone. But the storms which are often the cause of a necessary change to the alternate power line also put the telephone out of commission. The Northern Indiana Power Company therefore developed a complete radio control by means of which waves of frequencies outside the broadcasting range and having as complex a series of impulses as the combination lock of a safe are sent out on a dialing transmitter similar to those used on the automatic telephone. At Tipton there is a five-tube receiving set which amplifies these impulses and carries them to a series of selector relays which operate the oil-immersed circuit-breaker mechanism through storage battery switches. The apparatus was designed by John Ferguson of Indianapolis, and built by Westinghouse Electric and Manufacturing Company. Plans are being made for six other installations of a similar nature in Indiana. Similar radio control systems are being devised in England, a demonstration of the control of a substation at the Wembley exhibition by means of a wireless impulse from Manchester having been made before a large crowd. Selector relays are being used here, also, for control of a train of automatic switches. Demonstrations were given at intervals during the latter part of the exhibition.—*Electrical World* (New York), vol. 84, page 479, Sept. 6, 1924; also *English Mechanics* (London), Sept. 26, 1924.

Did the Ancient Eskimos and the South African Bushmen Meet in Europe 30,000 Years Ago?—Rock carvings recently discovered by an Egyptian explorer in the Libyan desert of Africa may have been made more than twenty thousand years ago by a race of people who probably migrated from Europe to southern Africa, and whose descendants now mixed with other peoples, are the African Bushmen. Disguised as a desert sheik and leading a camel caravan, an Egyptian explorer, A. M. Hassanein Bey, graduate of Oxford University, and First Secretary of the Egyptian Legation at Washington, D. C., crossed the Libyan desert in 1922 from the Mediterranean Sea, southward through Egypt and Tripoli. He was able to make several important corrections on the vague maps of this almost unknown country and had many interesting experiences with the local rulers of the oases through which he passed. In one of these oases, that of Ouenat, he made the most interesting find of his 2200-mile journey. This was a rock on which are carved lions, giraffes, ostriches and gazelles. The carvings are about half an inch deep and their age is shown by the fact that the edges of some of the lines are considerably weathered. "Who made these?" asks Hassanein Bey. "Here is a puzzle which must be left to the research of archaeologists. There are no giraffes in this part of Africa now, nor do they live in any similar desert country anywhere." "Perhaps," continues this Moslem explorer, "even more significant is the absence of camels from the drawings. If they had been native to the region at the time that the carvings were made, surely this most important beast of the desert would have been pictured. But the camel came to Africa from Asia not later than 500 years before Christ. Can these carvings antedate that event?" There exists quite good reason for thinking that the carvings antedate the year 500 before Christ by thousands of years. These carvings resemble to quite a marked degree the pictorial art of the Bushmen of southern Africa. They also resemble the art of a vanished race of men who are known to have inhabited parts of Europe, especially southwestern France, during the latter part of the glacial period. These people, called by students of the early history of man the Aurignacians, appear to have been negroids. In France and Spain they left on the rock walls of caverns a large number of drawings of animals. These drawings also have a remarkable resemblance to those made in modern times by the Bushmen of South Africa. So pronounced are the resemblances in the spirit of the art of the two peoples that several scientists, particularly Prof. Marcellin Boule, believe that if the Bushmen of southern Africa are not lineal descendants of the vanished Aurignacians of glacial Europe (mixed to some degree with other peoples with whom they have had later contact), then the two peoples at least had a common ancestry. It is believed that a people who probably had many physical characteristics



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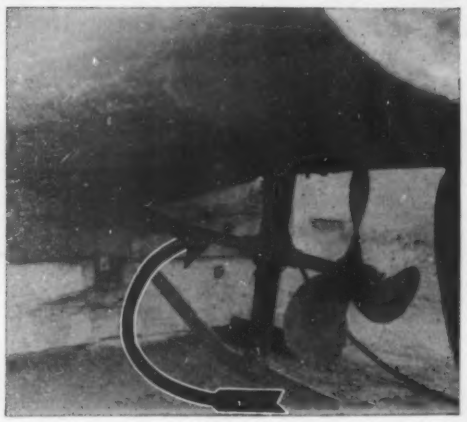

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in common with the modern Eskimos reached Europe not long after the close of the Glacial Period and drove the negroid Aurignacians out. In making war with them, probably during several generations, it is likely that the Aurignacians took Eskimo women prisoners and thus the two races may have intermingled. Today we find that the Bushman has a very noticeable Mongoloid strain, showing not alone in the color of his skin, but in the slant of his eyes. It is a far cry from Greenland to southern Africa; yet the grounds for believing that the ancestors of the modified peoples who now live in these two parts of the earth once met and fought, in Europe are fairly strong.—Partly from *National Geographic Magazine* (Washingnton, D. C.), vol. 46, pages 233-278, Sept., 1924.

Man and Cattle as Geological Agents.—Three thousand years ago dense villages nestled in the valleys of what is now the southwestern desert of the United States. Nearby were cliff dwellings. In both places lived a people who got their food supply by irrigating the fields and raising vegetables. Well-tended little fields of pumpkins, squash and Indian corn surrounded the villages and lay beneath the lofty cliff dwellings. Here and there near the fertile fields lay little irrigation dams of earth. These had to be built afresh every spring, for the mud that was washed down by the rapid streams usually filled them up. During hundreds of years these dams continued to be filled up and each spring more were built to take their places. Very little of the mud that reached the pools behind the irrigation dam's mud got away—the dams held it. Finally the river valleys, which had already been scoured out deep during the half-million year glacial period, became almost full again with rich alluvial soil. The surrounding hills were covered with dense grasses and other wild plants. These furnished food to a large number of wild animals. Then came the Navajo Indian and conquered the peaceful agriculturists. The Navajo grew nothing. He depended for his food on the livestock he kept. So the little dams fell to pieces and were never rebuilt. Moreover, the grass which had covered the hills and bound the loose soil together was soon cropped by the livestock until there was very little left. This, in turn, drove out most of the wild animals which had lived among the vegetation. Worst of all, it permitted the sudden and heavy mountain rains to wash away the soil. Trenches formed in this manner soon became gullies and the gullies became valleys. Now that the white man has come, the soil that was slowly accumulated by the dams, is being washed away still faster, for his paths and roads form the beds of torrents in time of flood. The landscape is returning to its original shape before the cliff-dwellers and villagers began irrigating. As the process of soil washing and gullying goes on from year to year signs of the earlier occupation keep coming to light. Here and there broken remnants of early walls of village houses peep out. Occasionally pieces of pottery, corncobs and various things lost and buried long ago turn up. These are positive evidences that man brought about the valley fillings in which they are buried. If one flies in an airplane over these filled-in and partly washed-out valleys the outlines of the filling can be clearly seen. The color of the washed-in soil delineates the few remnants of the alluvial fields of the early agriculturists as clearly as if they were outlined on a map.—*Science* (Garrison, N. Y.), vol. 60, pages 283-285, Sept. 26, 1924.

Doing Away with the Handpump at Filling Stations.—For the past three years there has been in service in Europe an improved method for pumping "gas" at filling stations by means of compressed air. This is called the Mauclère system, and it has worked a reduction in insurance rates in Europe. This is not, however, the ordinary method of keeping an air pressure over the liquid in the storage tank, a method which has serious drawbacks and which involves fire risks. In some cities the latter method is forbidden. With the new system the storage tanks are always at atmospheric pressure and only a few gallons of liquid are under pressure at any one time. The outfit consists of a small, power-driven air compressor, a vacuum receiving tank and a pressure receiving tank. This unit will serve one or any number of pumps, the air connection being made by pipes. Then there is the pump unit, consisting of two identical tanks holding 13 gallons each. Each has a float and the respective floats automatically switch the pressure to the alternate tank when the other tank has emptied, at the same time putting the vacuum on the emptied tank so that it may fill from the storage tank at some lower level. The process goes on alternating from left tank to right tank and back wholly automatically. At the French military aviation field, at Le Bourget, this apparatus is used to deliver three grades of "gas," with total capacity of 2500 gallons per hour. The compressor here uses only two horsepower, and as an extra fire preventive, nitrogen is used instead of air. The French government has five of these plants, the Spanish government has three. The Brussels fire department uses the new system, as does the street cleaning department of Utrecht, Holland. The system is also being used in steel plants, oil fields, tire factories, coal mines, chemical plants and others, for conveying vegetable oils, carbon bisulfide, oils and solvents for paints, etc. The fact that the material is moved by the steady pressure of a gas piston without coming in contact with moving parts appeals to the manufacturer of edible liquids, while the fact that a single air compressor unit will operate pumps all over a factory or large garage without the necessity of letting off all air pressure and stopping the supply of the liquid during the filling of storage tanks has a strong element of appeal.—*Compressed Air Magazine* (New York), vol. 29, pages 996-998, Sept., 1924.

Knock-kneed Railway Rails, a Coming Practice.—By canting or tipping railway rails inward so that their flat under sides are inclined to the tie on a slope of from 1 in 40 to 1 in 20, a number of the largest railways of this country agree that the rail wears more evenly and has a longer life. A canted rail holds a gage or spacing much better than a vertical rail, especially on curves, the flange wear on the wheels of rolling stock is decreased; engines stick to the rails better, the breakage of tie plates is reduced and there is less cutting in of the ties. *Railway Age* sent out a questionnaire to 37 typical railroads, asking to what extent each was canting the rail, the degree of inclination and the results. The replies indicate that about half of the railroads cant the rails as a regular practice, chiefly by the use of inclined or wedge-shaped tie plates. Proponents of the 1 in 20 slope advocate it because this slope corresponds to the coning of new wheels (the periphery of railroad wheels is not quite flat, the tread being the butt section of a prolonged cone). One reason this ratio is favored is that it brings the contact of the wheel over the center or web of the rail, instead of inside of it as is the case with uncanted rails. Again, this inclination offers an offset to the forces tending to turn or bow the rail out; *i.e.*, cause spreading rail. Other railroads prefer a milder slope of 1 in 40 or 44. The Erie, the Chicago and Alton, the Great Northern, the Lehigh Valley, the Southern Pacific and the Union Pacific, as well as others, all now cant the rail. But this practice is opposed quite strongly by the Pennsylvania, which maintains that the various arguments offered in its favor are unsound. Canting aggravates the cutting in of tie plates on curves; the argument based on the evenness of wear brought about by canting is theoretical; that based on counteracting side pressure of wheels on curves is unsound reasoning; and that based on canted rails holding gage better is a fallacy. The Rock Island also opposes the use of the canted rail, but 15 out of 36 railroads have adopted the practice since the World War.—*Railway Age* (New York), vol. 77, pages 404-407, Sept. 6, 1924.

Spotting Flaws in Castings with the X rays.—Within the past year the use of the X ray for examining important castings, especially cast steel, has been very greatly perfected. The advances made in this important work, which reduces the cost of manufacture in cases where it permits the safe substitution of cast steel for more expensive forgings, and which eliminates incorrect molding methods, are chiefly owing to the efforts of Dr. H. H. Lester, of the Watertown, Mass., arsenal. X ray examination of castings is now at the point in its development where it will very soon become a commercial method of insuring safety, and saving loss of property through discovering defective castings before they can cause trouble. Hidden, internal flaws, gas holes, shrinkage cracks, etc., are shown by the X ray and the apparatus used is but little different from that used in medical practice,

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LEAD gives to chinaware its beauty and lustre

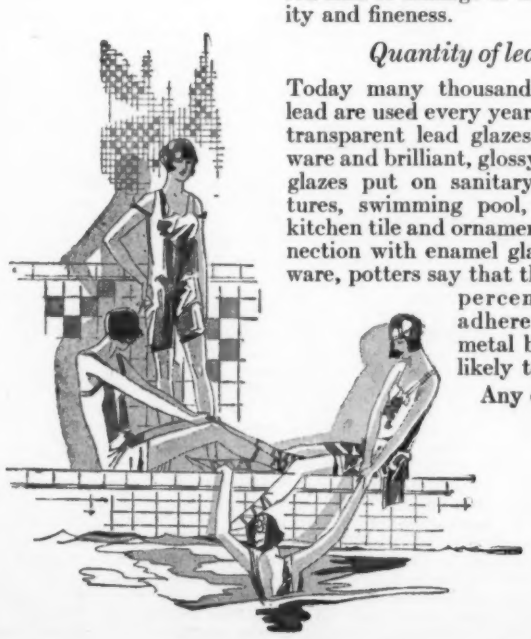
GLAZED china is nothing more than clay shaped in various forms and covered with a thin skin of glaze. It is this thin coating that transforms the rough porous clay body into a beautiful, smooth, lustrous china plate or cup or saucer. And in making this glaze, lead has always been one of the most essential ingredients.

For twenty centuries pottery has been coated with lead glazes. Green pottery made in China during the Han dynasty (206 B.C. to 220 A.D.) bore a lead glaze, as did the pottery of the ancient Assyrians and Egyptians. For hundreds of years Europe and every country influenced by European civilization have used pottery made of common clay covered with lead glazes.

At the very beginning of the pottery industry the desirability was recognized of using the lead products—white-lead, red-lead and litharge—in the manufacture of fine chinaware. With the growth of the industry there arose the need for the manufacture of these lead products by companies, such as National Lead Company, from which the pottery maker could depend on getting white-lead or red-lead or litharge of the required purity and fineness.

Quantity of lead used

Today many thousands of pounds of lead are used every year in making both transparent lead glazes for fine chinaware and brilliant, glossy opaque enamel glazes put on sanitary bathroom fixtures, swimming pool, bathroom and kitchen tile and ornamental tile. In connection with enamel glazes on sanitary ware, potters say that those with a high percentage of lead adhere better to the metal base and are less likely to crack.



Any one of the three lead products, white-lead, red-lead or litharge, can be used in making lead glazes. But potters usually prefer white-lead for the finest and purest results. Red-lead and litharge, however, if absolutely pure, make just as white a glaze as white-lead.

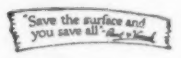
Makers of fine chinaware will use, as does one manufacturer, as much as 80,000 pounds of white-lead a year and only 1,000 pounds of red-lead. Others in the industry use large quantities of red-lead. They will reverse the above figures and use many times as much red-lead as white-lead.

The glaze on this china contains lead. The clay body is covered with the glaze mixture and is then heated to a high temperature to fix the glaze.

The use of lead paint

ALTHOUGH lead in pottery is constantly serving and helping to beautify your home, the tonnage of lead used in this way is not so great as that used in paint. Everywhere you go you see *white-lead paint* protecting houses from the attacks of weather. For generations the professional painter has used white-lead to save the surface. From our forefathers' time it has always been the standard for surface protection. Approximately 350,000,000 pounds of white-lead are used on wooden and other non-metallic surfaces each year. *Red-lead paint* prevents rust from eating into and destroying iron and steel.

So long as property is adequately covered with white-lead and red-lead, rot and rust cannot harm it. Property owners are awakening to the realization that paint protection is real economy. Many who never before seriously considered the truth of the maxim, "Save the surface and you save all," are now using white-lead and red-lead to protect their investments.



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except that an exceedingly high direct current potential of 200,000 or 250,000 volts is used. Work may be done on castings up to three inches thick. One of the interesting secondary developments of this new technique is stereoscopic X-ray examination. This permits the determination, not only the direction but of the distance beneath the surface of a flaw. A special stereoscopic negative is necessary, two exposures being taken under equal conditions, except that the X-ray tube is displaced the distance, center to center, of the observer's eyes. Then the two negatives are properly superimposed and viewed through the stereoscope, thus definitely locating the hidden holes just as if they were seen through a cast chuck of glass by the unaided eye.—*Iron Trade Review* (New York), vol. 75, pages 669-671, Sept. 11, 1924.

Using Sewage Wastes as Fertilizer.—Experiments with activated sewage sludge indicate that this new fertilizing material produces a marked response in plant growth, also that it is inoffensive and that there is no danger of injury to grass from heavy applications. It apparently has a high fertilizing value. Activated sludge, which is the sediment deposited in sewage tanks after the sewage has been treated with bacteria, had been an unknown product in the United States and its fertilizing value under different conditions has not been thoroughly established until recently. Some small, scattering tests have been made in this country, but they have meant practically nothing to the fertilizer manufacturer and consumer. The city of Milwaukee now plans to put in a sewage disposal plant which will produce about 100 tons of this material per day and it wishes to find an outlet for it, if possible, as a fertilizer. A big broad market would have to be created, however, and so scientific experiments had to be made on actual growing crops which had been fertilized with it, in order to prove that it was a good fertilizer. The city therefore placed a scientist at the University of Wisconsin to make the necessary experiments. He grew various crops fertilized with activated sludge, and in order to find out if sludge was as good he made similar tests on the same crops which had been fertilized with commercial fertilizers of the sort that have long been on the market. He found that corn and oats grew much better when fertilized with sludge than without it. One of the things that have to be found out about any new fertilizer is whether the nitrogen can be quickly taken up by the plant roots, or whether it takes several years for all of it to change to forms which plants can take up. Nitrogen is the element in fertilizer that helps mainly produce stalks, leaves and tops. Most fertilizers contain more of it than any other element. It was found that the nitrogen in sludge could be taken up by plants as soon as the nitrogen which is contained in sheep manure, fish scrap, cottonseed meal or tankage. It was also found that it could be used as a fertilizer for lawns and for golf courses, as it did not burn the grass even when used in large quantities. No bad odors developed from it, as is the case when the lawn is sprinkled with sewage. In fact, the nature of sewage is largely changed by the treatment it gets in the disposal plant.—*Canadian Engineer* (Toronto), vol. 51, pages 313-315, Sept. 9, 1924.

The "Lost Art" of Hardening Copper.—Methods of making copper hard enough to use for lathe tools for cutting and working the softer metals have been patented in the United States Patent Office. A myth that will not die has it that the ancients knew how to harden (mistermed "temper," which is to soften) copper. They did; but the product was either pure copper which was made harder by hammering, or an alloy of copper with tin, which is not copper at all, but bronze. One recipe for hardened copper (bronze) is: copper, eighty parts; tin, twenty parts. Add to this two parts carbon and one part borax. This specific bronze really has some merit behind it, and when cast properly makes a very fine casting which has a filing temper and which holds its edge as well as carbon steel quenched in water and drawn to a blue or purple. Tools made of it will work or machine any soft metal like copper, low brass, silver and gold, German silver, or tin. Its chief value, however, is to stock salesmen, who are more interested in getting their hands on green money than making a great advance in industry. Hardened copper has been a boon to such stock-jobbing careers. Says a writer, "The crowd I met selling stock had a line of cutlery, hatchets, axes, hammers, chisels and a milling machine equipped with cutters of supposed hardened copper. True, it is hardened copper, but not in the sense it is commonly supposed to mean, along the lines of a lost art of pre-historic age, which is bunk. The lost art of hardened copper is a myth. Chisels found were alloyed by the ancients with copper and tin. What show has hardened copper alongside of high-speed tool steel? Exactly the same show a snowball has in a hot July sun. But the lay mind prefers the bunk, because it's up in the planets, and they fall for it. The inventor who can produce a new metal with the strength of steel, non-corrosive and lighter in weight is in a position to oust steel." But, we may add, this has not yet been done.—*The Metal Industry* (New York), vol. 22, pages 352-353, Sept., 1924.

English Methods of Selling Automobiles.—In England, where very few of the motor car distributors sell one make of car exclusively, it is usual to find that the letterhead of a retail dealer carries the names of several makes of cars in addition to the words, "Any make of car supplied." They handle automobiles just as they might handle hardware or toilet goods. The total sales of cars in Great Britain in a whole year is less than one hundred thousand. One agreeable discovery made by the American who buys a car in England is that it will nearly always be delivered in two days or less. This is largely because distances are so small and roads are so good. But the dealer will not trade in your old car. You will have that to sell for yourself, as is shown by the immense number of advertisements for second-hand cars in British motoring magazines. In a few large cities, however, there are concerns which trade in second-hand cars only.—*Automotive Industries* (New York, vol. 51, pages 442-443, Sept. 4, 1924.

Increasing the Food Supply.—Possibilities of increasing the food supply of the world through study of agricultural factors as yet little understood are enormous, according to a recent address by Sir John Russell, F.R.S., before the British Association for the Advancement of Science. No attempt has been made in the field to control two of the most important of these factors influencing the growth of plants, light and temperature, although both now are subjects of experiment. There are four possible fields of experimentation which hold out promises of increasing both yield and quality: (1) Increase of plants in efficiency as transformers of the sun's energy. At present plants transform only about one percent of this energy. If some means of utilizing two percent would be obtained, it would make the average wheat crop in England 400 bushels per acre instead of the 200 obtained now. Increases in plant growth amounting to from 20 to 25 percent have been obtained in England by the influence of high tension electrical discharge which presumably acts by increasing in some way the efficiency of the plant as an energy transformer. The value of experiments along this line lies in the great increase in yield obtainable by a small increase in efficiency. (2) Adaptation of plants to both soil and climate. A soil moderately fertile under one set of climatic conditions may be absolutely unproductive in another. A clayish soil which in England is almost barren proves excellent grain and cotton land in the Sudan. Clay under wet conditions becomes a serious drawback. It might be possible to find some mathematical relationship between rainfall and the degree of objectionableness in clay. The fertility of soil in any given locality is dependent to a considerable extent on the fact that it fits in with the climatic conditions in supplying the needs of the plant. To make the complexity worse the soil itself is not constant but is always varying within certain limits. (3) Temporary changes in plants brought about by changed conditions, wholly independent of the plant breeder. It is a commonplace among farmers that certain soil conditions influence not only the yield but the quality of crops. At Rothamsted, England, the sugar content of mangold roots, an important factor in determining feeding value, was increased by increasing the supply of potassium to the crop. Grass has been increased in feeding value, quite apart from any increase in quantity, when treated with phosphates. Grain, however, has proved more difficult to alter by changes in environmental conditions although the protein in wheat has been increased by increased soil mixture. The Institute of Brewing in England now is making a full investigation

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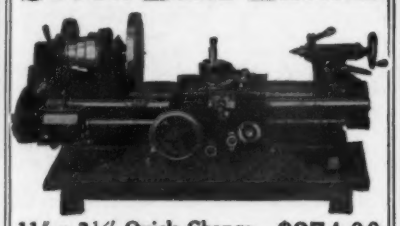

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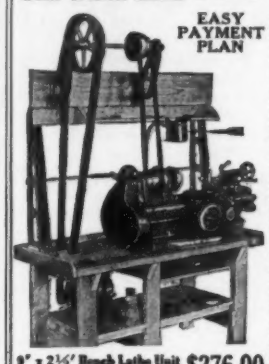

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of barley, still the basis for the national beverage. It has been found that increased moisture increases the amount of nitrogen in the grain and so also does an increased nitrogen supply, although to a much less extent. Other substances, such as both potassic and phosphatic fertilizers, may decrease the percentage of nitrogen, although they do not always do so. (4) Control of pests or parasitic diseases, which in England ruin at least 10 percent of the total value of the crops each year. These may be controlled, through study of the three controlling factors. Pests and parasites do harm only when they are present in an attacking state, when the plant is in a sufficiently receptive state, and when conditions are favorable to the development of the pest. Complete control of any of these three conditions would end all plant diseases, he said. If plants could be pushed through the receptive stages before the pest was ready they would escape attack. In the Sudan cotton thrips have been placed in a measure under control by giving the plants protection against the drying north wind and so maintaining a more humid atmosphere—a condition under which the plant thrives better than the pest and is past the stage of attack before the latter is ready. The best remedy still lies with the plant breeder by producing a variety immune to all diseases.

Differences Between Plant and Animal Diseases.—There are a number of important aspects wherein the diseases of plants differ from those of animals and man, and are more difficult to handle. The most important difference of all, perhaps, is the relatively small amount of help that the plant doctor gets from his patients. Animals and man frequently give themselves a lifelong cure of a disease by having it once; such permanent resistance is built up by an attack of smallpox—or its artificial shadow, vaccination—and is termed "acquired immunity." So far as is known, plants never acquire immunity and succumb to a second or third or twentieth attack of a disease as easily as they do to its first onset. It is true that a plant may be naturally immune from the beginning, just as some fortunate individuals in human society are immune to some diseases from birth. But even in such naturally immune plants, as well as in those more readily afflicted, resistance to attempted invasion on the part of the disease-producing parasite is limited to a small part of the plant tissues. The struggle takes place within the confines of a few cells. This is due largely to the absence of anything like a blood circulatory system in plants. Plant sap flows only one way or at least does not flow in a closed circuit, as does blood in animals. The more perfect circulatory system of animals permits all parts of the body to manufacture resistant substances, like antitoxins, which are then delivered to the fighting front by the transportation lines of the blood system. These two circumstances, inability of plants to acquire immunity by one attack of a disease and their lack of a circulatory system, render unlikely the development of anything like vaccination or serum therapy for plant diseases, and force us to fall back on the selection and breeding of plant strains with natural immunity, supplemented with spraying and other treatments to kill the disease-producing organisms as they alight on the leaves and stems of the plants. There are three principal modes of attack employed by the parasites that cause plant diseases. They may get in through accidental wounds, as corn smut does to a large extent; they may go in through the breathing-pores or stomata, like wheat rust; or they may actually bore or push their way in through the unwounded plant skin. The first two methods are employed by both bacteria and fungi; the third is used only by fungi. It has long been a riddle how a fungus, which is in the beginning a mere slender white thread, can push its way through the relatively tough skin. Early theories, which held that the fungus was attracted by some chemical substance exuded by the plant and in turn used chemical means to dissolve a hole through which it might pass, are now in abeyance. It seems more likely, in the light of recent investigations, that the affair is simply mechanical from beginning to end. The fungus thread seems to glue itself to the fated spot by means of a kind of gelatinous substance, while the central part of the thread pushes a hole through exactly like a shoemaker's awl. Once inside, the fungus may be virulent enough to kill the tissues and make a meal of them or it may simply

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"live along" with them, sucking out part of their nutriment, or the tissues may turn at bay and fight. Their resistance may be physical and consist of laying down a layer of cork or other tough, impenetrable substance against the invader; or it may be chemical, meeting the poison attack of the fungus with a poison counter-attack. Sometimes this struggle is so bitter that both fungus and invaded tissue kill each other.—Abstract from address by V. H. Blackburn, British Association Meeting, Toronto, Aug., 1924.

Colors, Stains, and Dyes.—The great majority of chemical substances occurring either as natural products or as the outcome of synthetic preparations in the laboratory are colorless. In other words, white light reflected from their surfaces or transmitted through these solutions is unaffected so far as its balanced colors are concerned and emerges unaltered. The absorption of light in these cases is general; that is, it takes place equally throughout the visible range of the spectrum and the object, therefore, appears colorless. On the other hand, there are a number of substances which possess the property of absorbing certain portions of the visible spectrum while reflecting or transmitting the remainder. These substances, therefore, appear to the eye to be colored in accordance with the portion of the spectrum transmitted or reflected. A red substance is one which absorbs the blue region of the spectrum; a blue substance one which absorbs the red region, and so forth. This is known as selective absorption. Again, there are a number of substances, chiefly members of the carbon family, which have the power of absorbing rays outside the visible region of the spectrum—for example, in the infra-red or the ultra-violet—and these substances, since they possess selective absorption, must be regarded as colored in a chemical sense, although the "color" they transmit or absorb is not visible to the eye. The hydrocarbon benzene is an example of the type of chemically colored substance—a property that causes it to be the parent substance of the coal-tar dyes. This power of a chemical substance to produce selective absorption is without doubt due to its chemical structure; white light is "filtered" through the molecular structure of the substance, leaving a "portion" behind in its passage. On the other hand, it is possible to produce visible color by entirely physical or mechanical means, as, for example, by ruling a number of fine lines on glass, and in these cases color is independent of chemical structure, being entirely physical in character. Nature, in producing the variety of colored substances around us, has adopted both the physical and chemical methods to achieve her ends. The color of flowers and leaves has been brought about by the use of colored chemical substances. But many of the color effects produced in the wings and feathers of birds and in butterflies are not due to the presence of any colored substance, but to the arrangement of fine filaments or hairs, which serve the purpose of disintegrating white light and reflecting the desired shade of color. A considerable number of the chemical substances which owe their color to structure are inorganic in origin, and the colors depend mainly on the presence of some color-producing metal; for example, chromium, cobalt, copper, and so forth. They are mostly used as pigments. Other such substances are compounds of carbon. There are some 300,000 definite compounds of carbon known, and research chemists add, perhaps, 4000 to these yearly. The majority of these compounds are colorless in the sense that they give only general absorption throughout the visible region of the spectrum. Some are, however, colored—that is, they give selective absorption within the visible region—and it is evident that in these cases the color must be due to some special condition of the element carbon. It is, in fact, due to what is known as the "unsaturated state." The greater number of known compounds of carbon are "saturated" in the sense that all affinity which the carbon atom possesses for the atoms of other elements if fully satisfied. This is the case when carbon combines with hydrogen to form methane CH_4, or when it combines with oxygen to form carbon dioxide CO_2. No carbon compound of this type possesses color, and every "saturated" compound shows general absorption of light. It is possible, however, to cause carbon to combine with carbon by more than one valency, and in such a case a condition of "unsaturation" arises. This means that the affinity of each carbon atom is no longer satisfied by its proper quantity of hydrogen (or oxygen), and since there is naturally always a tendency for the substance to acquire the hydrogen atoms necessary for saturation, the "unsaturated" condition is definitely less stable than the saturated state. The presence of one unsaturated linkage does not, however, confer color on an organic compound—at least two being necessary for the purpose. It is also necessary that the two double linkages should be separated by one single linkage. This is known as the conjugated system of double linkages, and it is the presence of this condition in an organic compound that apparently confers on it the property of producing selected absorption in the visible region of the spectrum. The great number of the derivatives of benzene are visibly colorless, but it is always possible to produce visibly colored substances from them by modifying the molecular conditions which lead to the selective absorption that causes visible color. —Abstract from article by J. S. Thorpe, *Nature*, July 12, 1924.

Never Break Children of Left-handedness.—Children who are broken of left-handedness by parents or by teachers will run a serious risk of becoming stammerers or stutterers. Either that or they may acquire a habit of eye squinting. So concludes a British surgeon after a study of over one thousand cases of these habits. The best way to cure cases of stuttering or eye squinting where it is known that left-handedness has been broken up in childhood is to retrain the sufferer in the use of the left hand. This method has proved successful in a large number of cases. There is a logical but hidden relation between the sources of the two manifestations, left-handedness and stuttering. Speech depends upon the integrity of the right side of the brain in left-handed people. Similarly, speech depends upon the left side of the brain in right-handed people. The change from left-handedness to right-handedness in some unknown manner involves the area of the grey matter of the brain which controls speech. Stammering or squinting, or both may result. Dr. W. S. Inman, senior ophthalmic surgeon of the Portsmouth and South Hants Eye and Ear Hospital, England, who is largely responsible for these discoveries, also states that he has collected one thousand cases of eye squint, very few of which have failed to reveal the existence of left-handedness or of stammering in some near relative. Going further, Dr. Inman states that stammering appears sometimes to have resulted even from an attempt to make a right-hander use both hands equally well. It is fairly common, he says, to hear that a squinter used to be a stammerer or left-handed in childhood, without any trace being present when he grew up. At present, since the discovery is a comparatively recent one, there is much to be learned concerning the exact cause of these relations between habits. Fortunately, since a cure may often be made so easily by simply reverting to the use of the left hand, the sufferer will not be so anxious over the discovery of the scientific reason for the cure as he will be gratified over finding a possible way to accomplish the cure itself. A number of cases which show the relation between these habits are described in *The Lancet* (London), vol. 207, pages 211-215; page 237; page 249; also see the editorial on pages 225-226, Aug. 2, 1924.

What We Know About the Vitamins.—Although we still remain in almost complete darkness regarding the chemical nature of the vitamins, there are not wanting indications that they are of relatively simple nature. A study of their stability under various conditions serves not merely as a pointer for future work in the direction of unfolding their chemical identity, but also in the meantime places in our hands data of great practical value. To deal first of all with the origin and distribution of the fat-soluble vitamin A, it seems now reasonably certain that this is synthesized by the plant, from which the animal obtains it, there being often a storage of the substance in the tissue fats. The vitamin cycle concerned in the origin of cod-liver oil is especially interesting. The marine diatom, *Nitzschia closterium*, forms large amounts of the vitamin by a synthetic process when exposed to light in sterilized seawater. Many other marine algæ also contain the vitamin. These simple plants form the food of such small animals as copepods, to which their vitamins are transferred. Similarly the copepods are eaten by small fish, and these with their derived vitamin are finally devoured by the cod, which thus gets the

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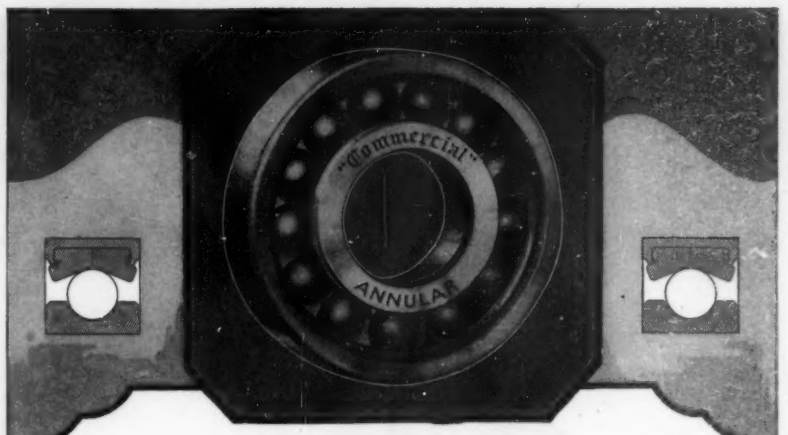
fat-soluble vitamin at third-hand. Vitamin A is often associated with the yellow fatty pigments called lipochromes, and though the occasional failure of this association shows that the substances are not identical, it seems quite conceivable that these two substances have some sort of common history which future investigation may perhaps reveal. Vitamin B is also derived from plants. Yeast is one of the richest sources of this vitamin, although it is still not quite certain that the vitamin is actually synthesized by the yeast cells. The animal body has little power of storing vitamin B, and hence the effects of lack of this vitamin appear very speedily. This is especially seen in the milk produced by mothers deprived of vitamins. Such milk loses vitamin B more rapidly than it does the fat-soluble vitamin A, because there is normally some store of the latter in the mother's body which can be drawn upon. Vitamin B apparently is excreted unchanged or but little altered, although in all probability not quantitatively. Of vitamin C we know even less; it arises in seeds, which did not previously contain it, when these are germinated. It is not stored in the animal body to so great an extent as vitamin A, although it is present in some of the tissues. The properties of the fat-soluble vitamin A are of considerable interest. As its name indicates, it is much more soluble in fats and in fat solvents than in water. Although it is relatively stable toward heat, even at 120 degrees centigrade in the absence of air or oxygen, it is soon destroyed by oxidation when oxygen is admitted, or by ozone. It is similarly stable toward alkalies in the absence of air. Vitamin B resists heat up to 100 degrees Centigrade, as well as exposure to air, a fact which is of practical importance as indicating that there is no appreciable loss of this substance in the baking of bread. This vitamin is also resistant to hydrolysis, both by acids and alkalies, is soluble in water and alcohol, but not in ether, and is readily absorbed from its solutions by animal charcoal, fuller's earth, etc. Vitamin C is extremely sensitive to oxidation, and therefore, under ordinary conditions, to the action of heat, and to drying.—Abstract from *Nature* for May 17, 1924.

The Respiration of Plants.—It has been known for some time that plants must get their oxygen through their roots as well as through their leaves, and that air taken in through the top of the plant does the roots little or no good in most species. It has, of course, been long observed that many kinds of plants "drown" when they stand for a considerable period of time in flooded land, even though their tops may be above the water. This "drowning" of a plant is exactly like the drowning of a man: both die of suffocation, or lack of oxygen. That the plant has its head above the water does it no good; it has no lungs or circulatory system to pass the air down to its roots, and if they can not get oxygen from the soil they can not get it at all. Two investigators, Livingston and Hutchins, have recently developed a most ingenious method for measuring how much oxygen the soil can supply in a given time. A cone-shaped filter of thin porous porcelain is sunk into the soil to be studied, and allowed to remain until the earth settles around it. Then nitrogen, from which the last trace of oxygen has been extracted, is fed slowly through from a storage tank, and, as it passes out again, is run through a solution of pyrogallol, a chemical that turns brown in the presence of oxygen, and can be used to measure the amount that has come in through the walls of the filter. By this method it was found that three factors influence the rate at which oxygen can pass through the soil to the roots of plants. Tightly packed soils can supply little oxygen, while well-cultivated soils pass it through easily. The rate of supply depends also on the amount of water present: the more nearly waterlogged the soil the lower the rate of oxygen movement. Finally, the deeper the soil level the slower is the rate of supply. The application of these results is readily seen. The natural distribution of plants is governed at least in part by the amount of oxygen their roots need. Plants of wet habitats, like rice, willows and cattails, require little oxygen for their roots; corn, potatoes and other crops of well-cultivated lands require a great deal. Ordinary forest trees for the most part occupy an intermediate position. It is expected that the new method will in time yield data of great value in botany, agriculture and forestry.—Abstract from *Science* for Sept. 5, 1924.



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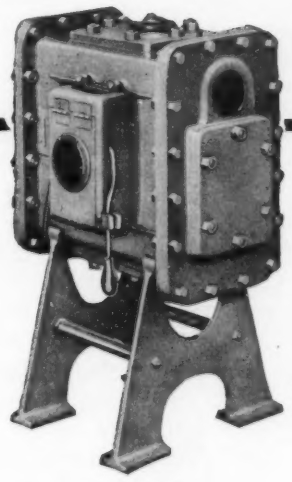

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Radio Notes

A Review and Commentary on the Progress in This Branch of Rapid Communication

Short-wave Directional Radio has been the subject of considerable study and extensive experimentation by Senator Guglielmo Marconi, assisted by C. S. Franklin. The experiments have been going on since 1916, and highly gratifying results have already been achieved. In Senator Marconi's own words: "All these results, many of which have greatly exceeded my expectations, convince me that by means of this system economical and efficient low-power stations can be established which will maintain direct high-speed services with the most distant parts of the globe during a considerable number of fixed hours a day. I am further of the opinion that by means of these comparatively small stations a far greater number of words per twenty-four hours could be transmitted between England, India and her distant Dominions than would be possible by means of the previously powerful and expensive stations. Another peculiar advantage of this system should not be overlooked. As distant stations situated only within a certain angle or sector of the beam are enabled to receive, this condition brings about a comparative privacy or secrecy of communication unobtainable with any other system of radio communication, and this may prove to be of the greatest value in war time, besides considerably increasing the number of stations it will be possible to work, by reducing the possibilities of mutual interference between them. The comparative economy in capital cost of these stations, the small amount of electrical power which need be employed, together with the capability of working at very high speeds, should make it possible to bring about a substantial reduction in telegraphic rates." At this time, when the cables are being greatly improved by the use of new alloys which speed up cable traffic several fold, short-wave directional radio is most opportune by way of giving radio telegraphy a new deal in transoceanic communication.

The Day of the One-wire Antenna has arrived, not only for the reception of radio programs, but also for the serious work of radio telegraphy. Exhaustive tests recently conducted by the United States Shipping Board have clearly shown that one wire will do quite as well as the usual three or four wires of a ship's antenna. As a consequence, three vessels are now sailing the high seas with a single-wire antenna. Tests were made with a single strand of 7-18 antenna wire, and observations were taken for both the inverted "L" and the "T" types. It was revealed that more than one kilowatt of radio energy could be "pumped" into this single-strand antenna in the absence of excessive sparking, although the results of these experiments would seem to indicate that this type of antenna could not be used on vessels equipped with two-kilowatt transmitters. However, the single-wire antenna seems entirely satisfactory for use with one-kilowatt transmitters, operating on wavelengths not exceeding 800 meters. Mechanically, the single-wire antenna has decided advantages over the multiple-wire antenna. The radio inspector of New York recently wrote the Commissioner of Navigation of the United States Department of Commerce: "This type of antenna has many evident mechanical advantages, both in regard to the original installation and the maintenance, and if the reports of its operation when transmitting and receiving are both satisfactory, it will probably be generally adopted by radio companies. It is particularly advantageous at this time when the neutrality requirements demand frequent raising and lowering of the antenna."

Semi-circular and Full- or Semi-straight Line Condensers.—The condensers generally used on present-day receiving sets are of the semi-circular type, that is to say, the rotor plates form a more or less perfect semi-circle. In this type of condenser the capacity is varied in direct ratio to the turning of the dial. This would seem, at first thought, to be correct practice, but upon careful consideration we find that this feature is a decided disadvantage. In tuning in broadcasting stations we tune in direct ratio to the square of the capacity, and as a consequence the low-wave stations are grouped almost inseparably together on the dials of semi-circular type condensers. The full- or semi-straight line condensers, on the other hand, tune similarly to broadcasting, and greatly aid in selective and sharp tuning. Of the two latter types the semi-straight line type is considerably less expensive and gives excellent results.

When to Discard Old Tubes.—With the present-day thoriated filament tubes, such as the UV-201-A, UV-199, C-301-A and C-299, it is no longer a simple matter to tell when the tubes have outlived their usefulness, at least their real usefulness. With the former tungsten filament tubes, a tube was used until its filament burned out. In the case of the present thoriated filament tubes the useful life of each tube is largely dependent on the presence of a certain amount of special filament material. It is this special filament material which is responsible for the prolific emission of electrons, which, in turn, makes the tube perform so well. This special filament material is gradually boiled out of the filament, so to speak, through continuous use, so that while the tube may continue to light, the activating material of the filament will have been exhausted. The simplest manner to test the condition of vacuum tubes is by direct comparison with new tubes. Thus it is good practice to keep a brand new tube on hand, using this tube in place of the regular tubes in the set so as to note whether the new tube improves reception. If it does, this may be taken as proof that the tube being replaced is nearing exhaustion. It is well to note that a tube which has become quite poor as an audio-frequency amplifier, may be used as a radio-frequency amplifier with fair results. The reason for this is that the radio-frequency amplifiers are subjected to very small loads as compared with audio-frequency amplifiers.

Preventing Distortion in Amplifiers.—If the radio enthusiast is not satisfied with two stages of amplification and wishes to go on to a third stage it is highly desirable to use what is known as a "power tube" or a vacuum tube of greater capacity than the usual amplifying tube. Such tubes can be used with a very low-ratio transformer and they are capable of handling a large volume of energy with 200 to 350 volts on the plate. To use this voltage it is necessary to use a "C" or grid biasing battery since the grid has a tendency to come positively charged which would paralyze this action. Sometimes the second stage of amplification must be provided with grid biasing. The use of a negative grid potential in amplifier circuits is a very important factor in obtaining the greatest possible amplification, without distortion and at minimum plate current. Indeed, a "C" battery materially reduces the drain on the "B" battery and is therefore incorporated in many receiving sets. The necessary grid potential depends upon the type of tube and the condition under which it is used and varies from zero to 9 volts negative. Tube manufacturers and transformer manufacturers usually specify the grid biasing potential. In order to obtain this negative grid potential a "C" battery comprising one or more flash-light cells is placed in the grid circuit at the point where the grid return is connected to the negative filament, with this negative terminal on the grid side. Where lower plate voltages are used sufficient biasing in the grid may be obtained by means of a potentiometer.

The Vast Field of Short-wave Communication is not generally appreciated by the radio laity. To begin with, it must be understood that the lower the wavelength, the higher the radio frequency, and it is the difference in frequency, which means the difference in wavelength, that determines the tuning of transmitters and receivers alike. Thus, on the very long wavelengths, the frequency becomes so low that there must be a considerable difference in the wavelength so as to have a sufficient difference in frequency to avoid interference. On the other hand, on the short wavelengths the frequency runs so high that a very small difference in wavelength will mean a considerable frequency difference and thus stand

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for freedom from interference. It is claimed by radio experts that there is room for all the stations in the world in very narrow bands of short wavelengths, since the difference in frequencies is very great at short wavelengths. For example, four meters is equivalent to 75,000 kilocycles and five meters is equivalent to 60,000 kilocycles. Since it is only necessary to have a frequency difference of 20 to 30 kilocycles between stations to avoid interference, it will be noted that it becomes possible to operate 500 to 750 stations simultaneously and without interference on wavelengths between four and five meters. There are numerous technical difficulties in the way of receiving such very low wavelengths, but these must soon be solved since radio progress seems to lie in this direction.

Noises and Superheterodyne Range.—As has been pointed out in these columns several times before, the limiting factor in present-day reception is noise, especially atmospheric noise. This is especially true in the case of superheterodyne sets. If it were not for the fact that tube noises and atmospheric disturbances hold us to a practical limit, we could keep on amplifying indefinitely. It is, therefore, of the utmost importance that our intermediate-frequency amplifier should amplify this type of interference as little as possible. Otherwise stated, it should be a pure radio-frequency amplifier and should not pass audio-frequencies with increasing volume. Now, the higher the wavelength which is used the lower the frequency becomes, gradually approaching an audible frequency. Accordingly, the higher the wavelength to which the amplifier is tuned the greater is its tendency to amplify audio-frequency noises. In fact, a radio-frequency transformer which is designed for wavelengths of 6000 meters or greater is a fair audio-frequency transformer, and a three-stage audio-frequency amplifier, even if its efficiency per stage is not great, can build up quite a volume of sound. Hence it will be noted how we are limited in the development of still more sensitive superheterodyne receivers.

The Thermiodyne is the latest addition to the ranks of radio receiving circuits. This four-tube receiver is claimed to possess the following advantages: The dial settings are absolutely predetermined. If the wavelength of a desired station is known, the operator can instantly tune in the signals of that station. The thermiodyne can be used with an outside, inside or even a loop antenna, and the signals come in at the same point on the tuning dial regardless of the type of antenna or external conditions. Under favorable conditions the receiver can be used without an antenna. The thermiodyne is free from squeaks, squawks or howls, no matter how it is handled. It will not distort broadcast music. As many stages of tuned radio-frequency amplification as may be desired can be placed before the detector. If properly constructed, this circuit is said to be as selective as a wave meter. Any number of thermiodynes can be operated from a single antenna, each receiving from a different station without interference. This circuit is the invention of Carl E. Trube, who worked with Professor Hazeltine in the development of the neutrodyne receiver. Because of the surprisingly uniform tuning of the radio-frequency stages in the thermiodyne circuit, it has been possible to group these tuning operations for a single control. The result is a radio receiver using six tubes—three stages of so-called thermionic frequency, detector and two stages of audio-frequency, all tuned with but a single control.

Lowering the Ground Resistance.—From Charles Manley of the Eagle Radio Company comes some solid advice regarding the lowering of ground resistance. Often the efficiency of a receiving set can be materially increased by getting a better ground connection, and sometimes several grounds are desirable. When this is done, if any benefit is to be obtained, each of these grounds must be tuned separately. For example, if two grounds are used, the receiver should be tuned to a definite wavelength using the ground which gives the highest dial reading on the antenna tuning inductance. An ordinary single slide coil is now connected in series with the other ground wire and ground post of the receiver and, without changing the settings of the receiver itself, the slider coil is adjusted until the received program is heard with maximum volume; that is to say, the receiver settings must be the same with either ground when used singly. When once tuned in this manner,

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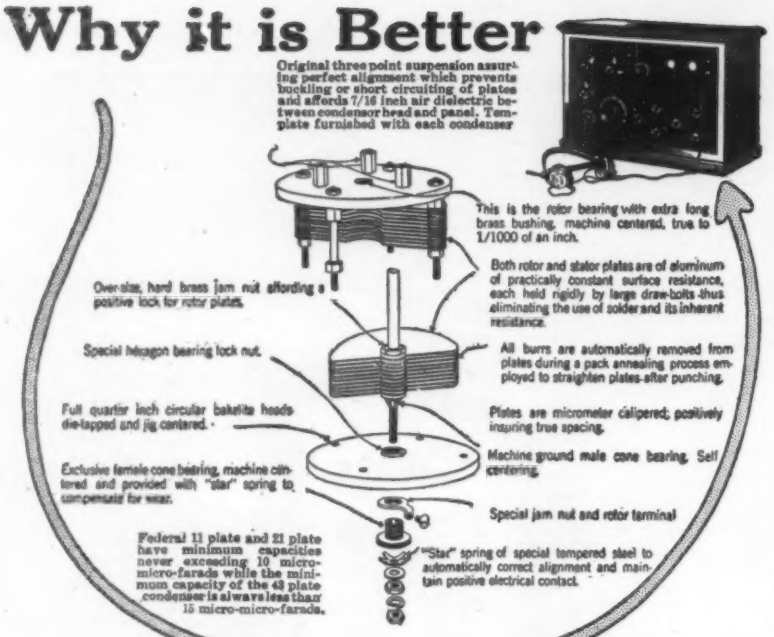
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the grounds may be permanently connected with the set and no further adjustment in this respect need be made. Any such ground tuning device, however, should be sufficiently removed from the set so as to be out of inductance relationship with it.

Never use two antennas at one time unless the same principle of separate tuning is applied.

Short-wave Transmission.—Recently station KDKA at Pittsburgh, Penn., has been transmitting its radio programs on a wavelength of 68 meters for repeating stations. These short-wave signals are said to be very loud in daylight, as well as at night. Station WGY at Schenectady, N. Y., has been transmitting on a wavelength of 15 meters, simultaneously with its regular broadcasting on 380 meters. Turning to radio telegraphy, we find that station POZ in Germany and station UFT in France are transmitting to station LPZ in Argentine Republic on about 77 and 88 meters, respectively. They are transmitting regular commercial messages by this means, and the amount of power used in each case is said to be ridiculously small, compared with the amount of power formerly considered necessary. They are probably using no more than five kilowatts, and this amount only when conditions are exceptionally severe. The regular transmitters at stations POZ and UFT, by way of contrast, use anywhere from 200 to 1000 kilowatts, on wavelengths ranging from 10,000 to 18,000 meters, and with antennas covering several hundred acres of land, to transmit commercial traffic to the United States.

Transatlantic Tests this year will take place during the international radio week, November 24 to 31. Extensive plans are being made this year to include all the American broadcasting stations, those in Cuba, Porto Rico, Hawaii, Canada, France, Great Britain, and even those in far-off Australia. Special programs will be broadcast from numerous American broadcasting stations during the tests, and foreign speakers of note will speak from our stations to their compatriots across the sea. The American stations have generally agreed to eliminate unnecessary transmitting interference during the receiving periods, which caused some trouble in receiving the English programs last year.

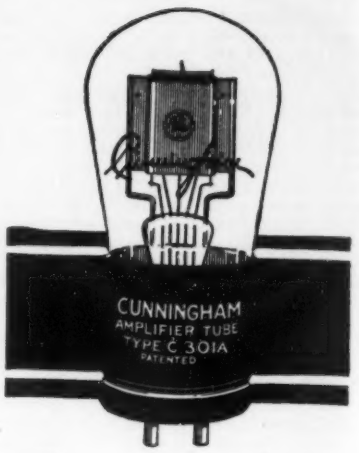
The Three-tube Neutrodyne has now made its appearance, taking its place side by side with the well-known four-tube and five-tube types. The main objects sought in producing the three-tube neutrodyne have been to obtain a smaller set which could be sold at a lower price and which would be more economical to operate. In fact, the three-tube set, using UV-199 and C-299 tubes, is operated on standard dry cells. The circuit employed calls for one stage of tuned radio-frequency amplification, detector, and two stages of audio-frequency amplification. One tube is reflexed so as to obtain the equivalent of four tubes. The tuning is simplified by reducing the controls to two tuning dials and one rheostat for all tubes.

Dead Spots at Sea.—While we have come to accept "dead spots" on land, there is another form of "dead spot" to be found right in mid-ocean, hundreds of miles from land, for which no adequate explanation has yet been given, according to A. Dinsdale, member of the Radio Society of Great Britain. Some scientists maintain that they are caused by large mineral deposits on the ocean floor, but this explanation hardly seems satisfactory, though it is true that such dead spots can also be overcome by increasing the wavelength used for communication. There are several such spots in the different oceans, and they cause quite an amount of inconvenience to ships at times, although the study of them is interesting.

The Low-loss Regenerative Receiver.—The old regenerative receiver seems to be getting a new deal of late, in the form of sets making use of low-loss condensers and low-loss coils. By means of these low-loss components, it becomes possible to build a regenerative receiver which is not only more efficient as far as sensitiveness and output volume is concerned, but also as regards sharp tuning.

High resistance in radio circuits is the cause of broad tuning.

Phonograph Attachments and Table-Talkers.—The demand for inexpensive, loudspeaker results has been answered in two ways, namely, the phonograph attachment and the table-talker. The former is a special telephone unit capable of handling the output of a two-stage amplifier without



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overloading, and of producing a good quality of music or speech. This device is provided with a special collar which serves to couple it to the tone arm of standard makes of phonographs. In this manner the radio programs are caused to issue from the phonograph horn, which has some advantages over the use of an unsightly horn. Furthermore, it must be noted that the usual cabinet phonograph has a horn some three feet long, usually designed and constructed with considerable care to eliminate distortion and extraneous noises. Excellent results may be had with the better makes of phonograph attachments. In fact, several manufacturers of loudspeakers supply the telephone unit of their instruments as a phonograph attachment. However, it is nevertheless true that the best of phonograph attachments will not give as good results as the usual run of loudspeakers. The reason for this is that the phonograph attachment and the phonograph horn generally do not balance acoustically. The horn is either too large or too small, and the reproduction is more or less faulty. The other device intended to meet the popular demand for low-priced, loudspeaker results is the table-talker. This is simply a slightly modified telephone receiver fitted with the proper horn. Since table-talkers sell for anywhere from $5 to $15, they should not be expected to take the place of loudspeakers; but given their proper rôle these devices will produce surprisingly good results. The table-talker is the logical step to make when the radio enthusiast has progressed as far as a receiver with two stages of audio-frequency amplification, and desires to get away from the ear phones. If the signals with his ear phones are such that he can lay the phones on a table and hear the radio programs several feet away, then it is safe to assume that his set will operate a table-talker with pretty fair volume.

Radio Aids Air Flight.—The recent remarkable flight of the *Shenandoah* to the Pacific Coast and back is not only a record for dirigible transportation and an indication of how important this type of aircraft may become in the future, it is also a record for radio. During the entire flight the ship was never once without radio communication with the ground. On several occasions it is reported that radio bearings and locality information furnished to the pilots was of substantial assistance in navigating the ship. Press dispatches were sent off regularly and in large quantity from the ship while she was in flight.

This remarkable record is a technical achievement for the naval radio laboratory at Belleview, near Washington, D. C. The radio equipment of the *Shenandoah* was designed at this laboratory and most of it was actually built there. The attachment of efficient transmitters and receivers to aircraft, where the usual procedure of grounding one side of the circuit is impossible, has been always a rather difficult matter. The success of the *Shenandoah's* equipment is an indication that this problem has now been solved satisfactorily.

Congratulations must go, also, to the radio officers and equipment of the German-built *ZR-3*. On the flight across the Atlantic the ship was in continual touch by radio with one or both sides of the Atlantic. This proved a very important matter in the receipt of weather bulletins and storm warnings.

Use Storage Batteries That Are Large Enough.—It often happens that trouble in obtaining first-class results with a radio set is due, not to the receiver itself, but to the fact that the storage batteries are of too small capacity or are charged at insufficiently frequent intervals. A slight falling off in the condition of the battery will not prevent its operating the set, but it will take the fine edge of perfection off the quality of the reproduction. If you want quality rather than cheapness in your radio outfit, it pays to put in a large capacity storage battery (150 ampere-hours is usually sufficient) and to have it recharged frequently "whether it needs it or not."

Smoke Will Absorb Radio Waves.—The smoke given out by a factory chimney or any other large and hot fire usually contains many electrified particles of the kind called "ions" and is a fairly good conductor of electricity. This means that if you try to operate a radio set in the shadow of a lot of smoking chimneys you may have trouble, due to the absorption of the radio energy by the smoke cloud in much the same way in which energy is absorbed by a steel building. The small amount of smoke given off by a house chimney is not enough, however, to have any perceptible effect.

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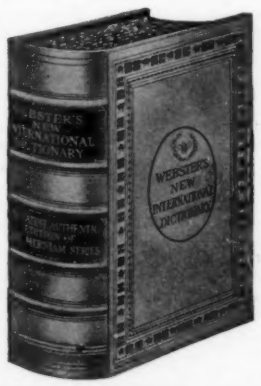

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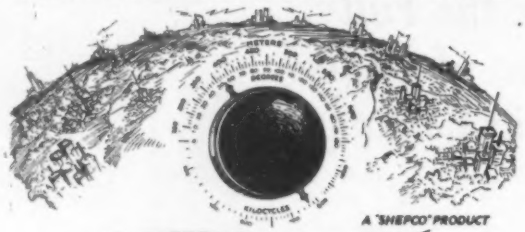

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Conducted by Albert A. Hopkins

This department is intended for queries of general interest. Only a small percentage of the queries we receive can be printed here, the great majority being answered by mail. Except in special cases we cannot solve mathematical problems, give directions for building machinery or answer queries of a special nature which belong within the sphere of the professional engineer. All queries must give the name and address of the inquirer and must be accompanied by return postage. In writing about book orders or subscriptions please use separate sheets, give your name and address on each.

Around the World in Thirty-six Days

L. K. W. says: *"Now that we have had the globe circumnavigated by aviators it would be interesting to know the record for the land trip."*

ANSWER: When Jules Verne wrote his fascinating story, "Around the World in 80 Days," he probably did not realize that within a comparatively short period this trip could be made in much abbreviated time. In fact, Phineas Fogg could now make the complete circuit of the earth in slightly less than thirty-six days. Numerous attempts have been made to beat the fictional record of Phineas Fogg by both men and women. The first of these journeys around the world against time was made in 1889 by Nellie Bly, in 72 days 6 hours 11 minutes and 14 seconds. Geo. Francis Train made the trip in 1890 in 67 days 12 hours and 3 minutes. In 1910, Charles Fitzmorris made the trip in 60 days 13 hours and 29 minutes and 42⅝ seconds, in the race for schoolboys conducted by the Hearst papers. The first record breaker to use the Trans-Siberian Railway was Henry Frederick, who in 1903 made the circuit in 54 days 7 hours 20 minutes. In 1907, Col. Burnley Campbell reduced the time to 40 days 19 hours 30 minutes. In 1911, Andrew Jaeger-Schmidt made a record-breaking trip, the elapsed time being 39 days 19 hours 42 minutes 37⅘ seconds. This trip cost $1426. Of this amount, only $596 was spent for railroad fare and transportation, while $600 went in hotels, food and tips. The record of Jaeger-Schmidt was broken in 1913 by John Henry Mears by 3 days 22 hours and 37 seconds. Mears made the world trip of 21,066 miles in 35 days 21 hours 35 minutes and ⅘ second, thus traveling at an average speed of 587 miles a day or 24½ miles an hour. Jaeger-Schmidt had traveled 19,300 miles at an average daily rate of 480 miles, or 20 miles an hour. During the entire trip Mr. Mears slept in a hotel but once, and that was for two hours in London. The trip cost less than $800; this includes the liberal tips he distributed along the way and the money he spent in bribing the engine crew of the Trans-Siberian Railway.

How to Cut Jet for Jewelry

R. L. M. *asks how to work jet.*

ANSWER: Small chisels of ordinary shape are used in turning jet on a lathe. The action is more of a scrape than a distinct cut. A knife the size of a penknife, with the point beveled off and then set like a chisel, is used in carving jet. Jet is first polished on a revolving wooden wheel with rotten stone and water, and then finished off on a board covered with stout leather—often porpoise hide—impregnated with rouge or lampblack mixed with a very small quantity of oil. Avoid too high a speed to eliminate heating.

The Largest University

A. C. B. asks: *"What university has the highest enrollment of students?"*

ANSWER: Probably Columbia University, New York City. Last year the enrollment was 32,379.

Amount of Air Used During Sleep

F. H. M. asks: *"What would be approximately the number of cubic feet air inhaled by a person during eight hours' sleep? About what percent of oxygen is used from the air by the body in breathing? Does air exhaled have greater specific gravity than air inhaled? Would such air have a tendency to settle to the floor of the room?"*

ANSWER: The average capacity of the human lungs is one gallon, or 231 cubic inches, but the average inhaled and exhaled at a breath is taken at about thirty cubic inches, thus the air is gradually changed in the lungs and their delicate surfaces are not exposed to the chill of air of a temperature much below their temperature. We may assume fifteen breaths per minute as normal, and thus it may be calculated that we inhale about 375 cubic feet of air a day. This is vitiated with four percent of carbon dioxide. This will vitiate 1500 cubic feet of air to one percent. This is *bad* air. If four parts in 10,000 of carbon dioxide are taken as the least to be permitted a man would require 37,500 feet of air each twenty-four hours. The oxygen removed from the air in twenty-four hours is enough to make the carbon dioxide. This may be calculated without difficulty. The exhaled air is hotter than the air of the room and thus at first rises. The carbon dioxide in it does not greatly increase its weight or density. Then, too, the carbon dioxide rapidly diffuses into the air of the room and will in time be found in all parts of the room.

Ink for Celluloid

N. B. C. *wants a formula for an ink for writing on celluloid.*

ANSWER: Ferric chloride, 10 parts; tannin, 15 parts; acetone, 100 parts. Dissolve the ferric chloride in a portion of the acetone, and the tannin in the residue, and mix the two solutions. Any pen may be used with the liquid.

A New Case of "Flexible Glass"

B. J. W. *sends us a peanut butter jar which he says was run over by a truck trailer and flattened.*

ANSWER: We submitted this jar to a large glass works specializing in the manufacture of intricate glassware for scientific and other purposes, as well as commercial lines, and they reply as follows: "It would indeed be a remarkable discovery to obtain a glass which would stand the treatment referred to. However, in this particular jar (as inspection in polarized light shows positively), the glass seems to have been reheated above the softening point. It very probably warped under its own weight or some slight load to the extent indicated. The burned food shown by the carbon deposit on the jar is further evidence of the reheating which has taken place. We estimate that the jar was reheated to approximately 1022 degrees Fahrenheit. It either got into the coal of a fire accidentally or on purpose. It has somewhat the appearance of being an ordinary college boy joke."

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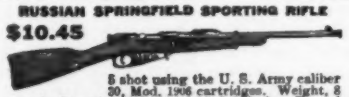

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Which is the Longest Day?

V. T. S. asks: "*I had always been under the impression that June 21 was the longest day in the year. But according to the almanac, there are several days around the period of the Summer Solstice on which the elapsed time between sunrise and sunset is virtually the same. To put the question in another way: Is there any one day in June on which the sun at noon attains its highest possible point in the heavens?*"

ANSWER: The longest daytime, that is, the time from sunrise to sunset, is about June 21, but varies a little from year to year. The Summer Solstice is the moment when the sun is exactly at its highest north of the equator. The Vernal Equinox is the moment when the center of the sun is on the equator as it crosses it going north. These times are measured by the astronomer to a hundredth of a second. At the moment of the Summer Solstice the sun is highest in the heavens in any northern place, or, as it is better expressed, farthest north of the equator. The length of daytime as given in an almanac which only gives the minute of sunrise and sunset, neglecting seconds, will not vary for several days at that season, but if you had seconds and hundredths of seconds, there would be but one day when the time from sunrise to sunset was the longest. Now, why does not this occur always on the same day of the year, say, June 21? That is because the time from January 1 to June 21 is not the same from year to year, while the time from the Vernal Equinox to the Summer Solstice is always the same. Every fourth year we insert an extra day in February which puts June 21 a whole day farther off from January 1 than it was the year previous, and this changes the relation of the almanac time to the astronomical events which do not vary as the calendar does. The answer to your question then is: There is a moment in June when the sun is highest in the heavens but that moment does not always fall on the same day of the calendar, although it is always at the same distance in time from the Vernal Equinox. A good almanac should give you the moment of the Vernal Equinox and of the Summer Solstice. These are respectively the time of the beginning of Spring and Summer.

How to Make "Pharaoh's Serpents"

J. B. W. says: "*When I was a boy, street fakirs sold little cones or pellets which produced a very amusing effect when lighted. I believe they were called "Pharaoh's Serpents." Can you describe the process of manufacture as they are no longer on the market?*"

ANSWER: This toy, as originally made, consisted of pellets of a very poisonous mercurial compound, which gave off dangerous fumes when heated. The "eggs" may be made of comparatively safe material by the following formula: Potassium bichromate, 2 parts; potassium nitrate, 1 part; white sugar, 2 parts. Powder each ingredient separately, mix, and press into small paper cones. These must be kept from light and moisture. Of course, neither this nor other chemical toys containing substances in the slightest degree harmful if swallowed, should be placed in the hands of children not old enough to fully understand the danger of eating or even tasting unknown things.

How to Fill Barometer Tubes

K. C. A. asks: "*Please let me know method of filling a barometer tube so as to get complete vacuum and proper height of mercury column.*"

ANSWER: Filling a barometer tube properly so as to include no air is not easy. The mercury should all be boiled in the tube. Put in not more than four inches and boil it by heating carefully and slowly over a flame. Herein lies the

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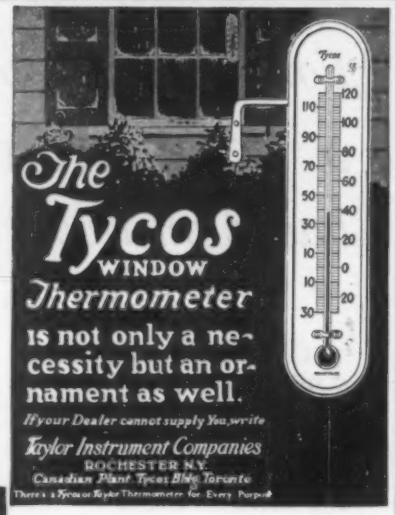
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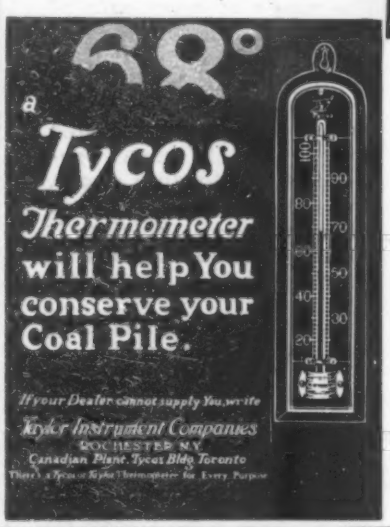
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difficulty. If you do not heat quite a section of the tube, at least six inches, it will break. Or if you heat the tube unequally it will suddenly break. Probably the experts heat the tube in a sand bath. When one section has been boiled to expel the air and has cooled another similar length may be filled and boiled as before. You will probably break several tubes in getting experience, but if you succeed you will have a barometer to be proud of. Usually amateurs take a wire with a small swab of absorbent cotton twisted in at the end and run this swab to the bottom of the tube. Then fill the tube with mercury and draw the swab slowly out. The cotton will bring with it nearly or perhaps quite all of the air in the mercury and on the glass in the tube. You should get much better than twenty-nine inches at sea level with a barometer filled with the swab of cotton employed to draw out the air. You can get the correct reading of the barometer at the Weather Station in your place.

Men Do Not Die With the Tide

E. F. J. says: *"Is it not true that at the seaside death usually occurs as the tide goes out?"*

ANSWER: No. We owe this popular fallacy to Charles Dickens, who encouraged it in "David Copperfield" and other stories. Popular fancy has seized upon a false analogy by which the life of the patient and the tide are both supposed to ebb at the same time.

It is the Impact Not the Fall That Kills

M. J. B. says: *"Is it true that a person falling from a considerable height (say 200 feet) is dead before the bottom or ground is reached?"*

ANSWER: No, this has been proven by persons jumping from bridges. Other cases may be cited. Unquestionably, however, a person with a weak heart might readily succumb to shock during the fall without the physical results of landing.

Did Japanese Earthquake Change Course of Ocean Current?

C. M. R. *asks if the course of the Johan current has been changed by the Japanese earthquake of last year which would probably result in a much hotter and drier climate for the Pacific Northwest. This year has been extremely dry in Oregon.*

ANSWER: We took up the matter with the Hydrographic Office, Navy Department, and Captain F. B. Bassett, U. S. N. Hydrographer, replies as follows: "You are informed that no information has been received by the Hydrographic Office which shows any abnormal conditions in the flow of this current. This office sees no reason why an earthquake that did not change the sea bottom should more than temporarily disturb a great ocean current."

The Cost of High School Education

B. W. U. says: *"What is the cost per pupil in a high school in a small city or where there is a large rural population?"*

ANSWER: Fortunately we have a government publication covering your inquiry. This is Bulletin No. 4, 1924, of the Bureau of Education, Department of the Interior. The school selected is a typical rural high school located at Mount Vernon, Washington. Two hundred and forty-two pupils come from farm homes and 170 from the little city of 4000 inhabitants. The cost per pupil was $136 last year. The pamphlet containing full information as to equipment and curriculum can be secured from the Superintendent of Public Documents, Washington, D. C., for ten cents in coin (no stamps).

"Glass" Windows for Movie Smashes

A. C. J. *asks for the composition of the doors and windows which are used in the movies where persons and things are shot through them, without injuring anyone.*

ANSWER: The following information was procured from Colonel Jason S. Joy of the Committee on Public Relations, and who is affiliated with the office of Will H. Hays: "What they do at the Long Island studio of the Famous Players, and they say the same thing is done on the coast, is to pour paraffin out in a mold so that it is very thin and use it for windows. It is translucent, not transparent, with a light behind it—being like a frosted glass window. It is very easy, of course, to show a real clear glass window and by proper cutting of the film, it makes it look like a person is thrown through the window, when, in reality, he is thrown through another window which is put in place of the real glass one. If you remember, stained glass windows are used a great deal, in which case, of course, it is very easy to substitute colored paper for the glass, and if a dirty window is shown, it is very easy to substitute paraffin for the real glass."

Thick Tumblers Crack Easiest

O. F. D. says: *"Will a thick tumbler stand hot water better than a thin one?"*

ANSWER: Glass is a poor conductor of heat, and when the hot water is poured into the thick glass tumbler the inner layers of the glass are soon at a much higher temperature than the outer. The higher temperature causes a greater expansion, and hence the outer layers are burst by the expansion of the inner ones (in many cases). In the case of a thin tumbler or a beaker glass the whole thickness of the glass is raised to practically the same temperature almost at once and consequently all the parts expand equally at once, and no excessive strains are produced.

Height of the Woolworth Building

A. Mc. N. says: *"What is the exact distance from the basement level to the highest point of the Woolworth Building?"*

ANSWER: We are informed by the superintendent that the exact distance from the basement level to the highest point is 829 feet, 7 inches.

What Does It Cost To Stop a Freight Train?

B. M. G. *asks what it costs to stop a freight train?*

ANSWER: This is an interesting question. If the train is running fifteen miles an hour it would cost $1.44 for each stop. The cost decreases with the speed. About ten miles an hour the expense is sixty-nine cents and it only costs twenty-four cents at five miles an hour. Freight trains are always stopping and these stops are a factor in freight rates and shows how intelligently railroad expenses are scrutinized.

What Is "Grade A" Milk

A. G. B. *asks how milk is graded?*

ANSWER: Milk is graded according to bacteriological content; not, as many people think, according to the amount of cream it contains. In other words, Grade A milk is not necessarily richer in cream than the B or C grades, contrary to general opinion. It is the number of bacteria found in milk which determines how it is graded. Grade A milk contains the fewest bacteria; there being no more than thirty thousand per cubic centimeter in this grade after pasteurization. In Grade B milk there are no more than one hundred thousand bacteria per cubic centimeter. In Grade C milk there are no more than three hundred thousand bacteria per cubic centimeter.

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Letters From Our Readers

The Aurora Borealis

To the Editor of the SCIENTIFIC AMERICAN:

For many years it has been suggested that the streamers in the Aurora Borealis and the Aurora Australis are intimately connected with electrical discharges between the sun and earth, and a few facts have been quoted to substantiate this belief, but to the writer's knowledge nothing more than meager and isolated observations have yet been set down to explain this wonderful phenomenon.

The past 18 months have given those living even in Old Ontario excellent opportunities for observation and study. It is well known that times of disturbances magnetic or electrical on the sun correspond to periods of maximum magnetic variations on the earth. Observations in connection with the eleven years' period of the sun spots conducted since about 1841, have shown a very close relationship between these solar disturbances and magnetic and electrical disturbances on the earth. Every appearance of a sun spot is not followed by an electrical disturbance on the earth, for theory and observation agree that from these disturbed areas on the sun electrical discharges are sent out into space in a cone-shaped formation, and it is only when the earth comes within this cone that the earth experiences the consequent disturbances.

We were well warned for the past year that great solar disturbances resulting in sun spots almost large enough for observation with the naked eye would take place on the side of the sun nearest the earth. We were thus well prepared to observe the earth's response and certainly Nature could not be more painstaking in revealing, demonstrating and redemonstrating the story in detail of the Aurora Borealis. Twice in the autumn of 1919 and for three successive nights in March, 1920, the fascinating demonstration was repeated.

I shall describe my observations on Wednesday, March 24th, 1920, compare them with those of a well-known experiment on Electrical Discharges in Rare Gases, and offer an explanation or a theory to which experiment observation and reason seem to lend very considerable support.

The laboratory experiment which reproduces almost every phenomenon of the Aurora may be briefly summed up as follows:

A closed tube into the ends of which are fitted conducting wires which may or may not be terminated by metallic electrodes has the air exhausted from it until the pressure is about ½ M.M. and is placed in a rapidly alternating field. When the discharge takes place between the electrodes, the following phenomena may be observed:

(1) A velvety glow, often appearing in patches, runs over the surface of the cathode.

(2) For some distance in front of the cathode is a comparatively dark region called the Crooke's dark space. The length of this dark space increases as the pressure diminishes.

(3) There is a luminous boundary to this dark space approximately parallel to the surface of the cathode. This luminous region, which comes next to the dark space, is called the negative glow, and it is a column of variable length and quite independent of the position of the anode.

(4) Following the negative glow is the Faraday dark space variable in length, sometimes distinguished with difficulty.

(5) The remainder of the tube quite up to the anode is occupied by a luminous space called the positive column. This region often exhibits striking periodic variations in its luminosity known as striæ. The distance between these striations increases as the density of the gas diminishes. These striæ often have an irregular motion of translation which obscures their distinctness. When observed in a revolving mirror many discharges appear striated which seem continuous when examined by direct vision. The positive column always takes the shortest path to the negative electrode and is made up of a succession of discharges by which the electricity passes between the electrodes.

These phenomena are also presented when metallic electrodes are not used, the chief difference being that the critical pressure, *i. e.*, the pressure at which it is impossible to obtain a discharge, is more easily reached. In either case, as the pressure is diminished the appearance of the discharge changes very much. At first the spark becomes more regular and uniform between the electrodes, then broadens out and assumes a fuzzy appearance of a bluish color. When the pressure is lowered still more the color of the discharge changes from bluish through reddish purple to reddish orange. When the pressure is lowered to about a hundredth of a millimeter streams of minute particles issue normally from the cathode. They may be deflected by a magnet, and they possess other remarkable properties. They are called cathode rays, and thus as the pressure is diminished the color again changes to white.

Now let us compare all these phenomena with those observed on the evening of March 24th, 1920. The sun and the earth formed the electrodes, both being electrified bodies. The polar regions of the earth being the locus of the greatest concentration of lines of force of the earth's magnetism facilitate the direct passage of the electrical discharges from the sun just as in the laboratory experiment discharges take place more readily along the lines of force in a magnetic field. The column of air, diminishing in atmospheric density or pressure as the altitude increases until passing beyond the atmosphere of the earth we have a vacuum as perfect as can be obtained in any closed tube, takes the place of that piece of apparatus. Electrical disturbances on the sun which have been almost continuous for some months supplied the necessary voltage. Thus did Nature set up the apparatus for an experiment familiar to Physicists, but on a scale so great that it took the sun and a planet 90 millions of miles away to support it.

What were the observations attending this demonstration of Nature's? After two brilliant displays on March 22d and 23d, I awaited the first signs of activity on the evening of the 24th. The sky was clear, the moon was but slightly advanced, conditions were ideal for observation. About 7:45 o'clock a dark mass resembling a cloud loomed up near the horizon and a little east of north; the experiment had just begun. The earth was the cathode and this dark cloud-like mass was none other than Crooke's dark space. A brilliantly luminous boundary to this dark space soon followed, and grew brighter and spread out until it formed a wide border. This was Nature's Negative glow. Beyond this a second dark space, but not so dark as the lower one, was at times visible. This corresponds to the Faraday dark space, and like it was at times inconspicuous though at other times it was quite discernible. In a few minutes the characteristic streamers shot up high toward the zenith and thus the positive column was presented. The periodic vibrations in the luminosity of these streamers demonstrated the striæ of the closed tube in a manner worthy of Nature, and at the same time so closely resembling those seen in a successful experi-

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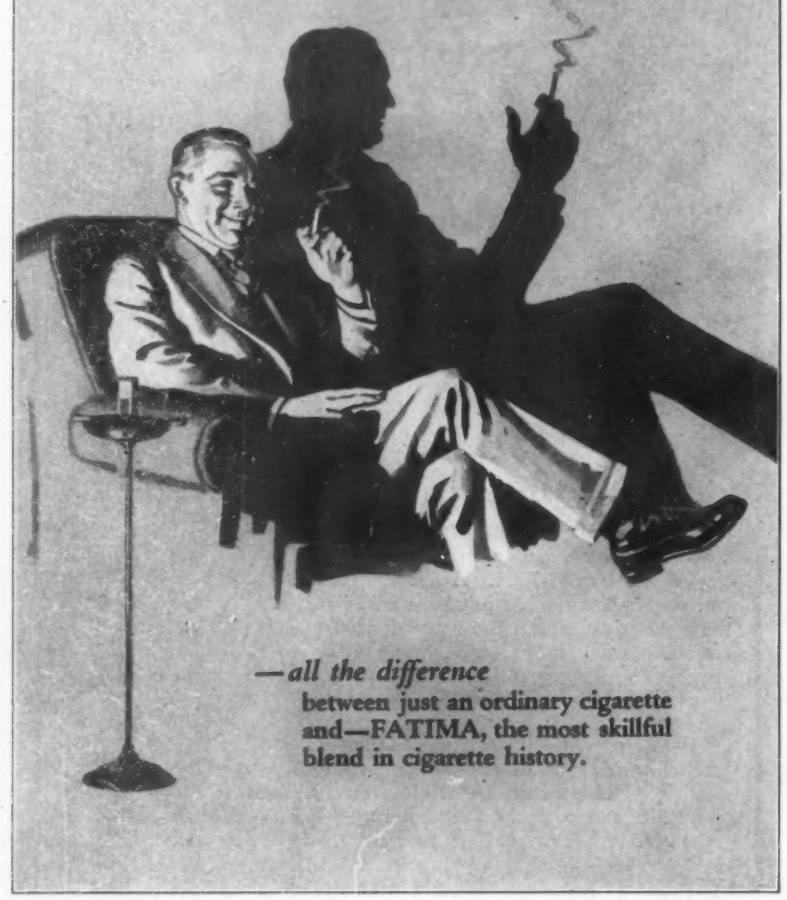

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ment that their identical nature could not pass unnoticed. The wave-like motion surged upward and retreated. Streamers swayed from right to left as the whirling earth varied the field of force or the density of the medium harmonized with the electric vibrations. Again and again two pencils of these rays were seen to exert a mutual repulsion, one shifting to the right while the other moved off to the left. This is exactly the behavior of the cathode rays in the laboratory experiment. All the colors common to the laboratory experiment were present, and there were none others. These colors were arranged in the same order according to the density of the atmosphere moving away from the surface of the earth in the order they appear in the closed tube as the air is being exhausted. The dark cloud-like Crooke's space in Nature's demonstration was clearly of an electrical nature. Its surface surged up and down as the streamers shot upward or retreated, another proof of the identical nature of the experiments. For, as mentioned above, the length of Crooke's dark space increases as the pressure diminishes, and certainly the pressure is diminished when these streamers shoot forth, for their whiteness associates them with very low pressures. The experiment lasted a couple of hours, during which time man's electrical messages by telegraph line and cable were held up, but Nature demonstrated in every detail "Discharges between Electrodes in a Rare Gas."

M. J. O'NEILL, M.A.
The Collegiate Institute,
Morrisburg, Ont.

Some Psychic Hypotheses

To the Editor of the SCIENTIFIC AMERICAN:

I have followed the course of the SCIENTIFIC AMERICAN psychic investigation with much interest. It is, I agree, a hard question and the results have not been convincing to a disbeliever in the claims of the mediums. I do not altogether agree with current explanations. Life is a mysterious thing and chemical and physical phenomena are but one degree less so. Can we be sure when we tie a medium with an organic substance (a rope), that some force—electrical, magnetic or otherwise—generated by or emanating from the body of the medium, may not alter the physical properties of the rope by increasing its elasticity, thereby allowing the medium to escape from or return to its bonds? Such an hypothesis seems to me less preposterous than some other suppositions. Much less so than those mentioned in February, 1924, SCIENTIFIC AMERICAN—especially the one referring to the fourth dimension.

In the case of psychic lights and materializations may they not be caused by chemical action—the formation of unstable compounds—caused by forces emanating from or crossing within the body of the medium? Both phenomenon seem to have a definite connection with the hands and head of the medium—just where concentration is greatest and where evidence most expected, as in a static electrical machine.

The cooling influence of the mediumistic trance upon the immediate vicinity can be explained upon the above supposition. The phenomena are peculiar chemical combinations caused by forces which have the medium for their seat.

The human body has been developed by the "life factor" (i. e., the spirit, soul, will, etc.) through evolution, partly by desire and effort of the life factor, but much more by exigencies and influences of surrounding conditions. It is a channel of expression for more forces than the life factor but as long as the life factor is dominant other forces are opposed and supressed and when the life factor is supressed or suspended as in a mediumistic trance, other forces may act through it as a channel and produce various peculiar phenomena.

Belmont, Ohio. ALLAN KEMP.

Science Notes

The Present Status of Fruit and Vegetable Dehydration

PROFESSOR WILLIAM V. CRUESS of the University of California discusses this important topic in a recent issue of *Chemical and Metallurgical Engineering*. He presents data relative to heat efficiency, volume of air required, effective humidity, air velocity, recirculation and critical temperatures. Types of dehydrators and commercial operations are also included. The results of experiments carried on by the U. S. Department of Agriculture, State Experiment Stations, and independent investigators are given in part and quoted here:

"The horizontal (or nearly horizontal) blast, tunnel type of drier with a recirculation system has proved more efficient and more economical of labor than the natural draft types.

"High relative humidity of the air used in drying has been found necessary for products which case-harden — *e.g.*, for pears, potatoes, tomatoes, large prunes and peaches. Most vegetables must be dried to a very low moisture content (less than 8 percent) to prevent considerable changes in flavor and color.

"Vacuum fumigation with CS_2 or heating to 145 deg. F. is effective against insect eggs. Not only the product but also the container (carton, box or can) should be treated, as the latter often contains eggs of the Indian meal moth, the most serious pest to dehydrated products. Low moisture content discourages their growth. Storage at 32 deg. F. will destroy insects and eggs.

"Moderate temperatures (below 150 deg. F., preferably below 140 deg. F.) give the best products.

"Static pressure (air resistance) has been greatly underestimated by many builders of dehydrators. Tests have shown that flues must be large and sharp angles in flues or tunnels avoided.

"Higher velocity of air than is now in common use has proved economical and desirable. A velocity of 800 feet per minute is recommended.

"Blanching (partial precooking) of most vegetables has been shown to be desirable, because it hastens drying, destroys enzymes which would otherwise cause darkening and loss of flavor in the dried product, and because blanching improves and "sets" the color.

"Very little sulfuring before drying is necessary for fruits to be dehydrated—much less than for sun-drying. Immersion in dilute salt solution still further reduces the length of sulfuring.

"Dipping grapes in boiling dilute lye for a few seconds cracks the skins and shortens the drying period to half or quarter the time required for undipped grapes.

"Wine grapes have been dehydrated in enormous quantities in California. (For the preparation of home-made 'grape juice'? Draw your own conclusions!) Tests have shown that such raisins may be stemmed, seeded and used for making pies, puddings, etc.

"The antiscorbutic value of dehydrated vegetables, especially spinach, is being studied by several investigators. Definite statements on this point would be premature at this time."

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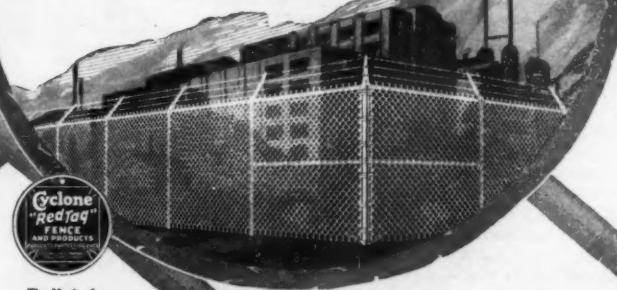

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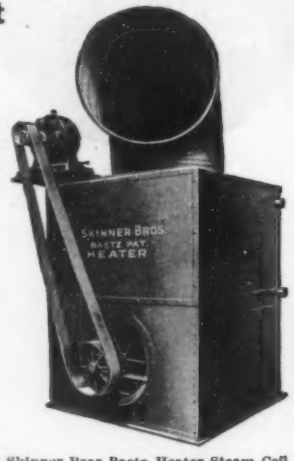

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then decomposed to the oxide. These earthenware shapes may be of various sizes and contours. The Laboratory experiments on a small scale indicate that the material is far superior to natural iron ore for the purpose of producing hydrogen, and there will soon be produced a sufficient quantity to permit extensive tests in the hydrogen plant at Langley Field.

Spectroscopic Alternations of the Chemical Elements

ONE of the important achievements of the optics division of the Bureau has been its recent tests of the spectroscopic alternation law across the entire periodic system of chemical elements. This work involved the analysis of complex arc spectra of elements appearing in columns IV to VIII of the periodic table. For some time work has been in progress on the arc spectra of titanium, vanadium, chromium and iron which occupy columns IV, V, VI and VIII, respectively, and in which no significant regularities had heretofore been detected. The structure of the chromium spectrum was reported some months ago. A paper on the regularities in the arc spectrum of iron was published the end of June, and similar work appeared in July, and a successful analysis of the vanadium spectrum has just been sent to press. These results prove for the first time that the structures of arc spectra alternate from even to odd groups throughout the system of chemical elements. Satisfactory progress has been made in connection with similar work on the arc spectra of platinum, nickel, cobalt and scandium.

A Fraudulent Gas Saving Device

THE priests of ancient Egypt devoted nearly all their inventive talent to devices for fooling the people and persuading them to part with their hard-earned cash, and some inventors today still devote much time and thought to the same purpose.

A device of this kind recently showed up for test at the Bureau of Standards, having been brought there at the request of one of its inventor's prospective victims. It consisted of a "gasoline saving device" with which, its inventor claimed, a car could make 54 miles on one *quart* of gasoline. The inventor proposed that the Bureau of Standards conduct a road test. The Bureau's engineers agreed, but insisted that the car be weighed before and after the test, and that the run be made to Frederick and back, a distance of one hundred miles. The inventor hesitated at these conditions, but finally gave his consent. His hesitation caused suspicion, and a thorough search of the car was made.

The search revealed two auxiliary tanks, one under the rear seat and one under the front dash. Both contained gasoline, and both were connected to the carburetor by means of hidden pipes. There was a valve, convenient to the driver's foot, with which these hidden supplies could be turned on. Thus the fraud was detected and the proper authorities were notified in case an attempt was made to place the device before the investors of the country.

To anyone familiar with gasoline engines, the absurdity of the inventor's claim is obvious. Power is required to drive the car, and this power is furnished by the engine. The engine in turn gets its power from the gasoline it burns. The laws of thermodynamics enable us to calculate the maximum efficiency obtainable with a given type of engine, a maximum which is limited by the temperatures the engine parts can safely stand. And this maximum is approached very closely in present day practice. Improvements may come as a result of refinements in the design, but no attachment could possibly give the marvelous increase in efficiency claimed by the inventor of this device.

Research Problems in Colloid Chemistry

DR. W. D. BANCROFT has contributed a list of problems in colloid chemistry through the Committee on the Chemistry of Colloid of the National Research Council. Parts of this report have appeared in the *Journal of Industrial and Engineering Chemistry* and the report as a whole is now available as No. 13 of the Reprint and Circular Series of the National Research Council. It is seldom that a comparatively new field in science can have the advantage of some two hundred problems being stated by an authority in such detail and with such clearness. It is out of the question to discuss these questions in detail here but the fact that they have been stated should make them available to a considerable number of students who desire to work in a new field of intense interest.

As an example, problem No. 70 is quoted:

"*Action of Hydrochloric Acid on Hide Power.*—Kubelka, found that the amount of hydrochloric acid taken up by hide power was 0.74 milli-equivalent of hydrochloric acid per gram of dry hide power, regardless of the concentration in the solution, at least from 0.01 N HCl up. This should mean that a definite chloride or hydrochloride is formed which shows no appreciable hydrolysis or dissociation when in contact with 0.01 N HC_3. This might be true; but Kubelka says that it is obvious that hide power will fix more acid in presence of sodium chloride. When he takes a 10 percent sodium chloride plus hydrochloric acid he finds that the amount of acid fixed is independent of the concentration of the acid as before, and that the total amount is now 0.97 milli-equivalent of hydrochloric acid per gram of dry hide powder. As a matter of fact, there is no reason why addition of sodium chloride should increase the amount of hydrochloric acid fixed by hide powder for the case where there is only one compound and it is not appreciably dissociated or hydrolyzed. Kubelka's results are, therefore, contradictory and must be repeated. To make matters worse, Kubelka finds that, with a 20 percent sodium chloride solution, the amount of acid taken up increases with the concentration of the acid."

Methanol

SOME time ago attention was called to the coinage of this word to be used in the future to designate methyl alcohol, commonly called wood alcohol. The purpose was not to obtain a shorter word for this important material nor to dignify it with a high-sounding title but to provide a trade designation which would not involve the word "alcohol" and consequently detract from the use of this material as a beverage by the uninformed. In one year in one of our larger cities there were fifty-four deaths traceable to the internal use of wood alcohol. As soon as the word methanol had been accepted by the trade and users, the number of deaths in the same locality dropped to less than twenty in a year. It is believed that a great deal more has been accomplished by this ingenious device than would have been possible by any campaign of education or legal enforcements.

Rubidium in the Sun

FOLLOWING up the suggestion of Dr. M. N. Saha that the principal lines of rubidium, which are invisible in the solar spectrum, should appear faintly in the spectra of sunspots, Prof. H. N. Russell has examined the fine set of plates of the spot spectrum taken by Brackett with the 150-foot tower telescope at Mount Wilson, and finds rather conspicuous lines very near the known positions of both lines of the principal pair of rubidium. These lines are strictly confined to the spot, are rather diffuse, and show a strong Zeeman effect. Professor Russell believes that they establish the presence of rubidium in the sun.

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As you read Page's letters, crisp sentences, brimming over with exuberance and spontaneity, follow one another with airy speed. Here is a word which no one else would use in just that way—and how it hits the mark! And here is a deft quip, so aptly phrased, so original, that you hold your breath in sheer delight.

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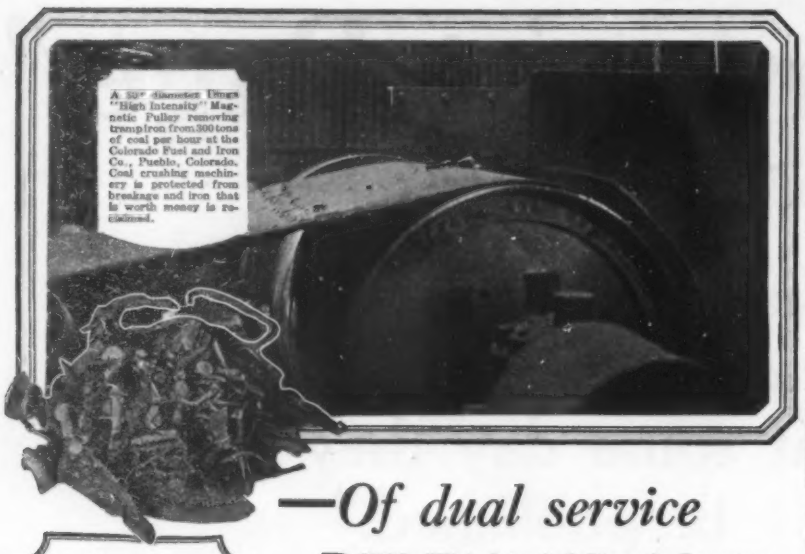
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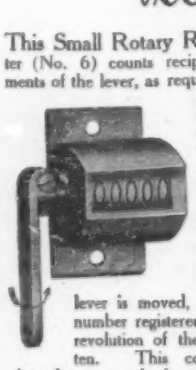

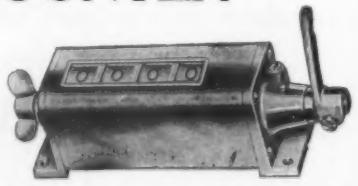

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Is Time the Fourth Dimension?

(*Continued from page 402*)

ception or some simpler mental synthesis which will show us that time and space are really the same in human feeling as well as in mathematical relativity theory. But that day has not yet arrived nor, to be frank, is it even in sight.

The answer, then, to the question which forms the title of this article, will depend upon what the inquirer means by the word "dimension." If he means to ask whether time is in all respects identical with space, so that we could move our bodies through time, if we knew how, as easily as we move them through space, the answer is no. It will probably continue to be no so long as men are human. Even in the strictest relativity theory there are, in fact, certain remaining differences between the time dimension and the three space ones.

But if the inquirer means to imply by the word dimension the possibility of choosing as a frame of reference for the universe a four-dimensional manifold comprising what we call space and also what we call time, the answer to our question is then in the affirmative. We can choose frames of reference as we will. If we are doing it in imagination we are not limited by the human senses. A space-time manifold may prove simpler and more convenient. But for men with fingers to touch things, with eyes to see things and with a time sense to feel the change from future into past, the distinction between space and time is still essential. For man time is not the fourth dimension.

Space and time are the fundamentals of the common human frame of reference for the facts of the world, but it is worth while to point out that the fact of their being so fundamental—more fundamental, for example, than visual space or than the possible space conceptions that might be built on sounds or smells—probably means no more than that the muscular sense that has been responsible for our idea of space and the internal chemical sense that has formed our idea of time are the two human senses that seem almost never to be lacking. Many men are blind, many others are deaf, still more numerous are those who lack the sense of smell. A set of space-time concepts built on any of these senses would have to leave many people out of account. These unfortunates would stand outside the space and time of the rest of humanity. They would be actually idiots, "idiot" being merely another name for a man who thinks in a fundamentally different fashion from the rest of us.

It is even an interesting speculation whether some actual cases of so-called idiocy may not be due to the lack of one or both of these most fundamental human senses; the muscular sense that gives us space or the chemical sense that gives us time.

Scientific Tests for Good and Bad Singers

(*Continued from page 383*)

voice in the case of voices that have had bad training or no training at all.

Now we can see why the singing of a moderately loud tone may require more breath than it should. It may be sung with the muscular indication proper for either a softer or a higher tone. This will be inefficient. More air will be required.

Accordingly, when the experimenter finds that a certain singer uses more breath for the moderately loud tones than for the soft ones, or when he finds that the breath emitted varies irregularly as the singer goes from the soft tones to the louder ones (as is illustrated by the middle left-hand curve of page 382) he knows then that the coordination of the vocal cord muscles is not perfect and that the voice is not being produced in the simplest and most efficient way. The next step is to set vocal exercises that will tend to correct this and to provide the muscular development and coordination that is so necessary. Fortunately, this can often be done.

This is merely one instance, of course, of how the characteristics of a voice can be read off from a study of the breath emitted during the singing of different tones. Another one is the conclusion—one that has the greatest possible practical importance—to the effect that the control of breath by the respiratory muscles is not really a factor in tone production.

Although this is a statement of the most revolutionary character, the results secured in these researches leave no doubt as to its truth.

Some other applications are suggested by the curves of page 382. Still others are under investigation and there are some that have not yet been investigated at all. For some of the more complex voice characters, as, for example, the ones that musicians include under the term "quality," it will be necessary, doubtless, to study other physical indications in addition to the breath emitted.

It may safely be assumed, however, that a perfect set of breath-expulsion curves will indicate a voice in which "quality" and all other characteristics are essentially perfect. It may be said, also, that the proper development of an untrained voice is essentially a matter of securing satisfactory coordination and development of the muscles which control the vocal cords and the shapes of the resonating cavities, especially of the upper throat. Singing cannot be learned by imitation. The muscles must be exercised and trained.

The important point, as we view this investigation at present, is that physical methods can be applied with profit to the study of singers and of the technique of singing. To a considerable extent this can be done from the curves alone, without actually hearing the singer at all. During this investigation, for example, one of us was able to deduce from the curves for a certain singer the characteristics of that singer's voice although he had never heard it. These deductions proved to be substantially correct.

It becomes possible, therefore, for a competent teacher who is also a physicist to estimate the possibilities of a singer and to prescribe the general features of proper training without a personal hearing, even, indeed, when the singer and the teacher are half the world apart. The day of physical methods in the singing studio has arrived. How the details of these methods are to be worked out and used to the best advantage is something that we can safely allow the future to decide.

Laboratory Type of Electric Furnaces

FOR all scientific and industrial research purposes high temperatures are obtained by means of electric furnaces, which may be broadly classified as follows: (1) Wire-wound or ribbon-wound tubular furnaces; (2) graphite spiral furnaces; (3) carbon-tube furnaces; (4) tungsten and iridium-tube furnaces; (5) zirconiayttria tube furnaces; (6) granular resistor furnaces; (7) induction furnaces, low frequency and high frequency types; (8) arc furnaces, and (9) cathode-ray furnaces.

The Range of Radio Stations

ACCORDING to Capt. R. C. Trench of the British Army, the principal factors determining range are: (1) Wavelength employed; (2) natural wavelength of sending antenna; (3) power of sending plant; (4) height of receiving antenna. There are additional factors, such as (5) nature of intervening surface; (6) time of day; (7) atmospheric conditions, and (8) degree of reliability required.

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Lack of space makes it impossible to give many cross-references, or to enter a given reference in more than one place. Each article is therefore entered where it is believed it will be most easily found. In every case the general subject should be sought, rather than the supposed specific title of an article; the article may not be indexed under its specific title at all, but may be entered under a statement of what it is about, so that it may the more readily be found by one seeking references to its subject matter. We call special attention to the classifications "Household Appliances and Furnishings," "Machines, Machine Tools," "Machinery and Power," etc., under which many items will be found whose location otherwise would be very puzzling. These groups may be examined item by item for a doubtful entry with much greater ease than can the entire alphabet. The individual articles on the chemistry and motor truck pages are indexed separately; the short notes comprising the columns of text on the advertising pages are sometimes indexed if important.

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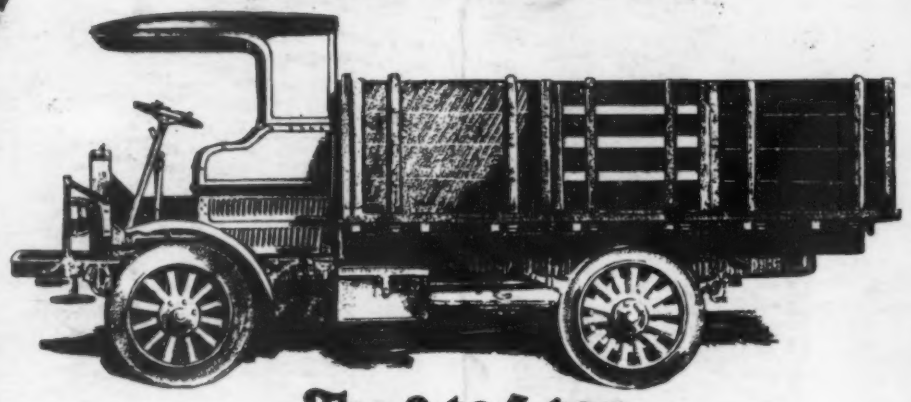

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